In conclusion the committee makes the following recommendations:

(1) That each company conduct its own experiments for train resistance.

(2) For the present for such experiments the dynamometer method shall be used, and the resistance of train alone determined.

(3) That the determination of the amount of pull available at the draw-bar at various speeds for locomotives of the different classes, be left to the proper motive power officials.

(4) That speeds be determined as closely as 0.1 mile per hour.

(5) That for experiments on heavy freight trains at low speeds, the formula should have the shape $r = a + b V$.

(6) That an additional term be added to show the effect of loading.

(7) That all tests for train resistance should be made on tangents.

(8) That for determining the sum allowable to save curvature, or to save rise and fall, the average line for train resistance should be used.

(9) That for grade revision, for questions of momentum grade, a maximum line above the average train resistance should be used, a line somewhat near the outer edge of the experiments plotted in a diagram.

The Admission of Trade Wastes into the Sewers of Reading, Pa.

The improvement and extension of the sewerage system of Reading, Pa., and the construction of sewage disposal works have brought up the subject of the disposal of the industrial wastes of the city. Until recently very little attention has ever been paid to industrial sewage in this country, except in the course of the research work done by the Massachusetts State Board of Health. The various liquids from manufacturing establishments were allowed to run into the sewers as a matter of course, and their effect was disregarded. As the necessity of treating sewage before its discharge into bodies of water becomes apparent, the importance of knowing more about the trade wastes it contains is recognized. Sometimes it is the cause of a large part of the nuisance due to the discharge of raw sewage into a river, and sometimes it complicates the purification processes. On the other hand, any sweeping refusal to admit industrial wastes into a sewerage system is likely to cause needless hardships on manufacturers, putting them to large expense in order to dispose of these liquids in some other manner.

The authorities of Reading decided to have this subject investigated before the new system was definitely adopted in all its details, in order that manufacturers might be given all possible facilities for removing this class of wastes and, at the same time, the city might be assured freedom from well-founded future complaints about nuisances due to sewage disposal.

It was accordingly determined that it was the part of prudence to settle all such questions in advance of the operation of the sewage disposal works, and thus anticipate and avoid the troubles some other cities have had. In reaching this conclusion the city had the benefit of the advice of Dr. S. G. Dixon, State Health Commissioner, whose official duties require him to be in close touch with all sewage disposal works in the State. The problem at Reading is readily understood. The city has a separate sewerage system, and at present a portion of the trade wastes enters the sanitary sewers, but a majority of them enter the Schuylkill River or a canal running alongside it, either through private drains or indirectly through connections with the storm sewers. The result is that the waters along and below the city river front are polluted to an objectionable degree. The Board of Public Works accordingly requested the city engineer, Mr. Elmer H. Beard, and the consulting engineers, Messrs. Hering & Fuller, to determine the best way of getting rid of the wastes. It is, of course, desirable to discharge as large a part as practicable through the storm water drains, and those which cannot be removed in this way must not be allowed to impose unreasonable burdens on the sanitary sewers and the sewage-disposal works.

ANALYTICAL CHARACTER OF EIGHT REPRESENTATIVE TRADE WASTES. (PARTS PER MILLION.)

Source.	Oxygen Consumed. Total. 3-Min. Cold.	Oxygen Consumed. Total. 5-Min. Boil.	Oxygen Consumed. Dissolved. 3-Min. Cold.	Oxygen Consumed. Dissolved. 5-Min. Boil.	Total Organic Nitrogen.	Suspended Matter. Tot.	Suspended Matter. Vol.	Suspended Matter. Fixed.	Iron. Tot.	Iron. Dis.	Chlorine.
Tannery	64	441	20	112	130.7	2954	1465	1489	5	tr	1466
Paper mill	13	85	9	59	26.7	710	149	561	5	tr	216
Brewery	28	423	17	377	29.8	569	254	282	8	tr	166
Pickling liquor	...	...	...	...	....	504	320	184	..	..	....
Dye works	29	122	21	92	27.1	119	102	17	3	1	366
Wool hat factory	10	42	6	23	23.8	101	80	21	2	tr	125
Felt hat factory	18	57	12	43	20.5	77	54	23	4	4	233
Electroplating works	9	24	8	20	19.1	97	48	49	22	19	566

In approaching this problem a statement of all industrial establishments in the city was prepared in the office of the city engineer, first by taking the names and addresses of all industrial establishments from the directory and later checking and supplementing the list by a systematic inspection throughout the city. This resulted in a corrected list of about 130 establishments which required detailed study. Each one was then examined by an inspector from the city engineer's office. After these returns were available the more important places were investigated by Mr. George A. Johnson, principal assistant engineer with Messrs. Hering and Fuller. The city and consulting engineers also personally examined conditions along the river and canal and investigated those establishments whose trade wastes present the more difficult problems, owing either to their volume or to their character. Much care was also given to collecting evidence indicating the volume of trade waste from the various establishments, as shown by the quantity of water used from private sources and from the public water supply, or both. In order to ascertain more definitely the character of the trade waste, samples from typical works were collected at 15-min. intervals for an entire day and portions of the well-mixed product thus secured were analyzed in triplicate by Mr. Howard Gerber in the city laboratory under the direction of Mr. Johnson.

In regard to the quality and quantity of trade waste recorded in their report the engineers point out that these products vary much, and that the result of investigations at one period, no matter how thoroughly they are carried on, does not necessarily mean that it will be strictly applicable for another period. Accordingly the quantities were recorded on a liberal basis as representing maximum conditions; and the average trade wastes, both in quality and quantity, will probably fall somewhat below the figures presented.

In seeking corrective measures for the pollution of the river and canal now due to trade wastes, the engineers endeavored from the outset to keep in mind that no material should be received into the sewers which will injure them, pumping equipment or purification devices, or seriously interfere with their normal operation.

The volume of wastes from nearly all establishments was found to be so small that this is not a serious feature. In several cases, however, the quantity assumes such large proportions that it is imperative that these volumes should be discharged at a fairly uniform rate. To discharge at short intervals such large amounts as would overtax the capacity of the sewers and of the pumps is inadmissible, and if need be, establishments should be required to put in storage tanks, the engineers report, so as to allow a fairly uniform discharge.

Coarse suspended matter, such as felt and fibre from hat factories, should be removed before entering the sewers, in order not to clog the purification devices. The solid matters in suspension which will deposit in the pump well ought to be removed in settling tanks before the liquid enters the sewers.

All these items, it is pointed out in the report, are related more or less closely to the local conditions at the works and to the financial policy of the city, especially as to whether the benefits to be derived from the use of sewers by industrial establishments shall be paid for out of the tax levy or whether they shall be paid for partly or wholly by special assessment on the establishments benefited. If the assessment method is adopted the benefits should certainly not involve a cost to the industrial establishments, in excess of that for purifying the sewage by individual local plants.

In considering the disposal of trade wastes, exclusive of sanitary wastes, they were divided for the sake of convenience into three classes by the engineers: A, wastes which do not require withdrawal from the canal or river; B, wastes which require withdrawal from the canal or river and cannot be allowed to enter the city sanitary sewers; C, wastes which require withdrawal from the canal or river and may be allowed to enter the city sanitary sewers.

Inspections show that there are two groups to Class A, those which are already connected with the sanitary sewers and those which are not objectionable and which can continue to discharge into the river or canal with some small changes in local arrangements. Only one kind of waste was found which must be taken out of the river and canal and cannot enter the sewers, the wastes from gas works.

Class A.—There are 69 industrial establishments in the class which may continue to discharge their wastes into the river or canal. In general they are foundries, boiler works, machine shops, rail mills, knitting mills, brick works, glass works and similar industries where the wastes are not unsanitary.

Steam power is used in most cases. There is some oil discharged from the works, coming from exhaust steam and from water used for cooling purposes at some of the mills, especially the iron works. A large portion of the oil can be kept separated from the water. It gives an unattractive appearance to the canal and river and should be removed from the waste liquid leaving the works. This can be done without much expense at each establishment by building suitable basins with scum-boards, the surface accumulation in which should be removed from time to time. All water closets and wash basins, as already stated, must be connected with the sanitary sewers, as soon as practicable.

Class B.—The only wastes of this class, requiring local treatment, are those of gas works. Some of these find their way into the sanitary sewer system of the city at present, but for the most part they reach the river and canal, where much offense has been occasioned by them in the past on account of odors and the unsightly appearance of the river below the points of discharge. A number of times considerable trouble has been occasioned by fires on the river from burning oil in the wastes discharged from these works. These wastes should be rigidly excluded, not only from the Schuylkill River and canal, but also from sanitary sewers, the engineers report, and their treatment on the grounds of the gas works should be insisted upon, it is stated, as they would seriously interfere with the operation of the sewerage system and disposal works. The sanitary wastes from these establishments should be taken into the city sanitary sewers and withdrawn from the cesspools or Schuylkill River into which they are now being discharged.

Class C.—There are 62 establishments where the trade wastes cannot properly enter the river or canal, but may enter the sanitary sewerage system. Of this number 29 are at present connected, including a small brewery and a dye works outside the sanitary sewer districts, which cannot be connected to the new works for some time. The total quantity of trade wastes now to be taken into sanitary sewers is in round number 1,500,000 gal. daily for six days in the week, or roughly 10 per cent. of the water consumption and also of the dry weather sewage flow. This is equivalent to the average sewage flow of a population of about 10,000 persons. There are half a dozen establishments, hat factories, a tannery and dye works, each of which discharges from 30,000 to 60,000 gal. of trade wastes daily. All other establishments discharge small quantities, comparatively speaking, with the exception of two paper mills, each of which discharges about 500,000 gal. of wastes every 24 hours. If these waste liquids are discharged with care, the engineers see no reason, so far as quantity is concerned, why they cannot be received into the city sanitary sewers without making any increase or extension to the latter as now designed.

The amount of coarse suspended matter in the trade wastes is practically negligible except in the case of hat factories. These discharge too much felt or fibre, and before the liquid is received into the sewers it should be freed from such matter, either by screening or by the use of settling basins.

Representative samples of the trade wastes in different kinds of industrial establishments were collected with as much care as possible and analyzed by Mr. Berger in the city laboratory with the results given in the accompanying table.

Samples analyzed with the results given in the table indicate that more or less suspended matter would deposit in the receiving wells at the pumping station. Most of the deposit, however, would occur in the septic tanks. There are times when the amounts of fairly coarse suspended matter in the wastes of the paper mills and tannery are so high that it may be necessary, Messrs. Hering and Fuller state, to require these works to install settling basins in which to clarify the trade wastes before they enter the sewers. As a matter of precaution the city should reserve the right to require such settling basins as needed before giving permission to these establishments to connect with the sewers.

The first point to ascertain in this connection is whether or not any of these trade wastes will interrupt or prevent the disposal works operating in a normal manner. Some trade wastes exert a germicidal action, and the engineers accordingly investigated this matter with special care and tested samples in the laboratory. They are satisfied that there is no danger in this regard and that the only bearing upon disposal will be in the increased volume of liquid to be handled, containing about 3.5 tons daily of suspended matter, one-half to two-thirds of which would deposit in the septic tank.

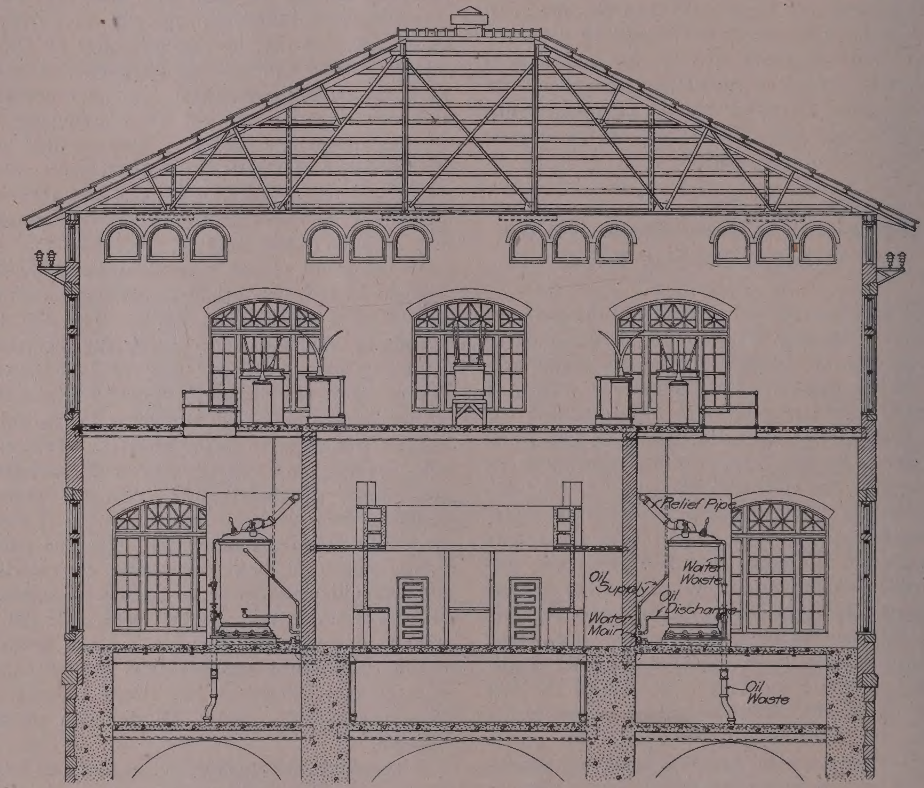
There will be an additional cost due to purification of these wastes, which will very nearly double the volume of sewage now entering the sanitary sewers. This cost involves the pumping equipment, size of the pipes from the pumping station to the works and the capacity of the septic tanks and filters. It also affects the cost of operation and maintenance for both pumping and purification.

The Great Falls Station of the Southern Power Co.—II.

By Curtis A. Mees and John H. Roddey.

Generators.—The electrical equipment consists of eight 3,000-kw., 60-cycle, 2,300-volt generators; twelve 2,000-kw., 2,200/44,000-volt step-up transformers, two 400-kw., 250-volt exciters, a suitable switchboard, indicating instruments and switching apparatus.

The normal load of each generator at 100 per cent. power factor and 2,200 volts is 786 amperes, each machine being direct-connected to a water-wheel unit of 5,200-h.-p. capacity. These machines may also be operated at 2,530 volts. The revolving field has 32 poles and is so designed that when supplied with 200 amperes at approximately 160 volts the generator delivers its normal output at 100 per cent. power factor, while 260 ampere excitation is required when delivering the normal kilowatt output at 80 per cent. power factor. The field and the armature are to stand an instantaneous high potential test of 15,000 volts and 6,000 volts respectively. At 100 per cent. power factor the voltage variation from full load to no load shall not exceed .7 per cent.



Section through Transformer and Switch House.

The temperature rise guarantees are as follows: After 24 hr. operation at normal current and normal voltage the rise by thermometer shall not exceed 35° C. After 24 hr. operation at 115 per cent. voltage 125 per cent. current and 100 per cent. power factor, the rise shall not exceed 50° C. The efficiency guarantees are:

Load	Full	¾	½	¼
Efficiency	96	95½	94	90

The exciter installation consists of two 400-kw. 250-volt eight-pole compound-wound generators, each direct connected to a 700-h-p. water-wheel unit. The generator capacity is such that with but slight overload one machine may furnish excitation for the complete installation of generators. At normal rating (250 volts and 1,600 amperes) the temperature of no part of this generator, including bearings, shall after 24 hr. run be more than 40° C. above that of the surrounding atmosphere, when this is 25° C. Following this test a 24-hour run at 25 per cent. overload shall not cause an ultimate rise in temperature of more than 45° C. above that of the surrounding atmosphere. Momentarily the machine will carry a 75 per cent. overload without injurious heating and with practically no sparking at the commutator.

The efficiency guarantees are as follows:

Load	¼	½	¾	Full	1¼
Efficiency	80	88	91	92	92

Transformers.—The transformer installation consists of four banks of three transformers each. These are water-cooled oil-insulated, the rated capacity of each being 2,000 kw. These machines are designed to step up from 2,200 volts to 44,000 volts, and by means of multiple connection the additional ratios of 550/11,000 and 1,100/22,000 volts may be secured. Provision has also been made whereby, by means of taps, the secondary winding may be operated at 1,900, 2,000 and 2,100 volts, connections for different voltages being made inside the tank.

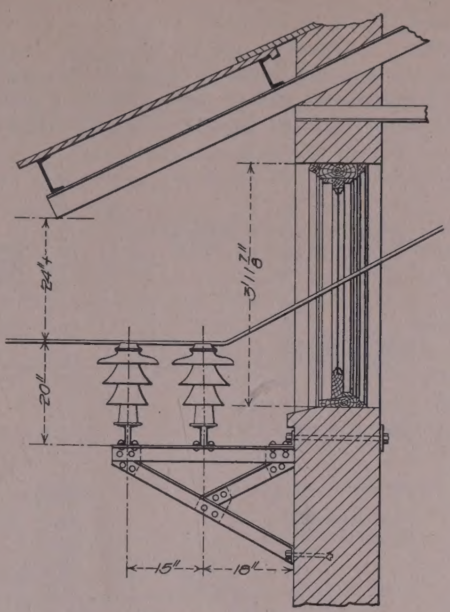
With a temperature rise not exceeding 40° C. the transformer will operate continuously with a water flow of 4 gal. per minute; while if a flow of 5 gal. per minute is maintained the temperature at 1¼ load and 115 per cent. voltage will not exceed by 55° C. the temperature of the intake water.

The guarantees are as follows:

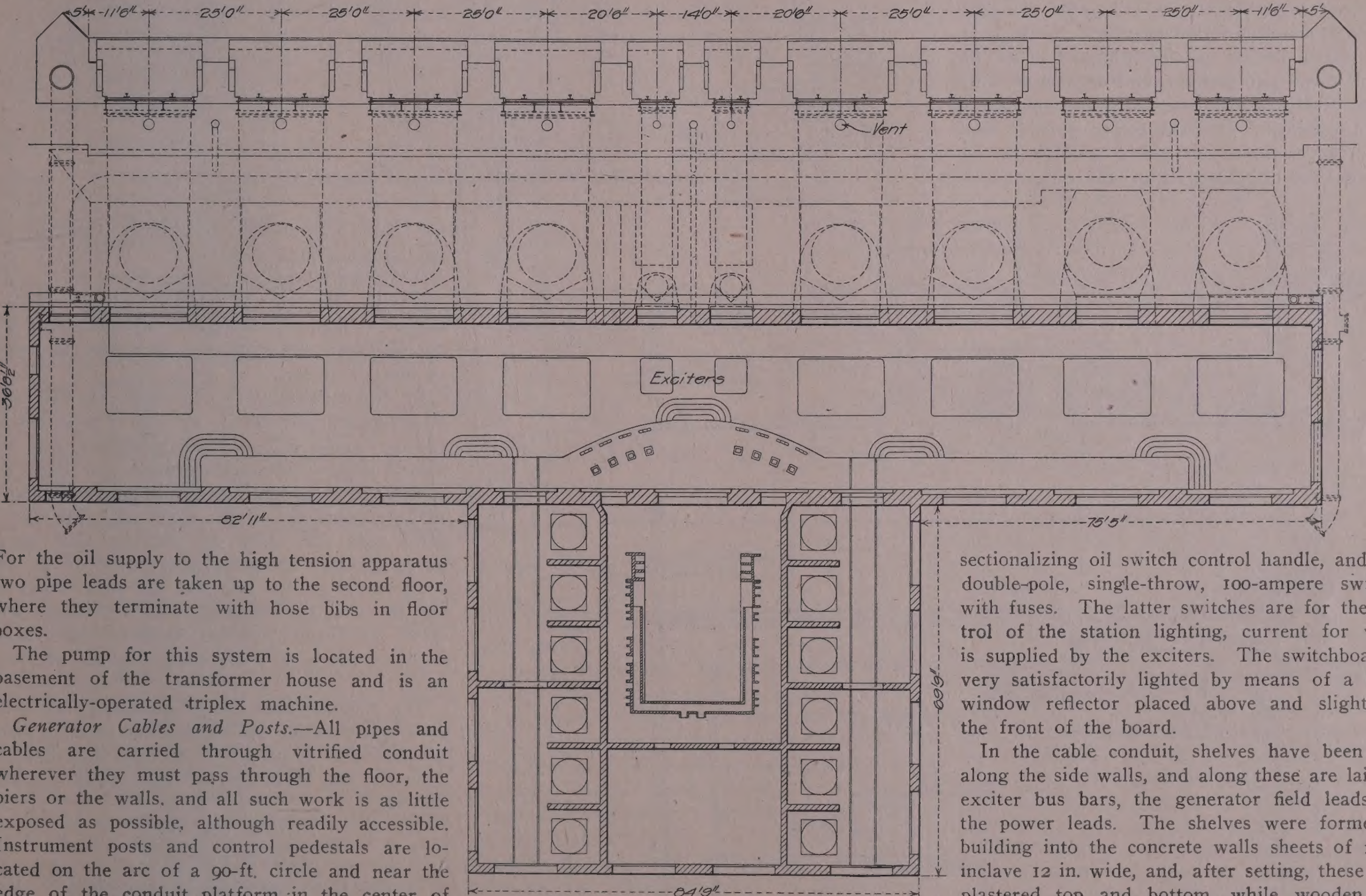
Power factor	100	90	85
Regulation	0.95	2.4	2.9

Load	¼	½	¾	Full	1¼
Efficiency	96.4	98	98.3	98.4	98.3

The tanks are designed to withstand a pressure of 150 lb. per square inch, and in order to provide against damage in case of explosion all transformers are connected through relief valves to a 6-in. vent pipe discharging outside of the building. Transformers are mounted on flanged wheels and stand in their respective compartments on 30-lb. rails supported on concrete pedestals. A transfer carriage operates upon a track in front of each row of transformers, and any of these may readily be removed from its support onto the carriage and thence into the power-house, where it is accessible to the crane. All transformers are connected to a pipe system by which carbonic acid gas may be admitted to the tanks in case of fire. The carbonic acid gas generator and pressure tank are located in the basement of the transformer house, and from them a main pipe extends to a cabinet in the low-tension switching room, where the distributing pipes to the several transformers branch off. Each branch pipe is provided with a valve numbered to correspond to that of the transformer to which the pipe is connected, so that by opening the proper valve a fire may be extinguished in any tank. A pipe lead also extends to the second story, where by means of a hose connecting from a floor box, any of the apparatus there may be reached. Cooling water is supplied by gravity through pipes tapped into the heads of the exciter turbine cases. Oil may be supplied either by gravity or under pressure from a storage tank outside of the building, or by reversal of the pump it may be drawn off and returned through a filter to the storage tank. Should it have deteriorated to an extent not permitting its further use it may be wasted into the tailrace.



Line Window, Switch Room.



Plan of Power Station.

For the oil supply to the high tension apparatus two pipe leads are taken up to the second floor, where they terminate with hose bibs in floor boxes.

The pump for this system is located in the basement of the transformer house and is an electrically-operated triplex machine.

Generator Cables and Posts.—All pipes and cables are carried through vitrified conduit wherever they must pass through the floor, the piers or the walls, and all such work is as little exposed as possible, although readily accessible. Instrument posts and control pedestals are located on the arc of a 90-ft. circle and near the edge of the conduit platform in the center of the station, while the transformer switches and the outgoing line switches are controlled from the switchboard placed in an arched opening in the wall separating the power house from the transformer house. The power cables, exciter bus bars, field leads and rheostats are located beneath this platform in the conduit, a more detailed description of which will be given later.

For the control of each generator there is provided an instrument post and a control pedestal. Each instrument post has one 3,000-volt voltmeter, one 1,200-ampere ammeter, one 4,500-kw. polyphase indicating wattmeter, and one 400-ampere field ammeter. In addition to the above there are two synchronizers, two frequency indicators, and four 3,000-volt bus bar voltmeters, distributed among the several posts. Each control pedestal contains a switch for the remote control of one non-automatic oil circuit-breaker, one 400-ampere, double-throw, double-pole field switch, a rheostat hand wheel and sprocket chain, an eight-point voltmeter receptacle, a synchronizing lamp receptacle, a meter shunt and a lamp reflector. The lamp and reflector are so arranged that a bright light is thrown on the meters, the supporting pedestal of which is located immediately behind the control pedestal.

The two exciter control pedestals each contain a 300-volt voltmeter, a 2,400-ampere ammeter, a hand wheel and sprocket chain for operating the field rheostat and two single-pole, double-throw, 2,000-ampere switches. The field rheostats for generators and exciters are located in the conduit directly beneath their respective control pedestals. An equalizer pedestal provided with a 2,000-ampere, single-pole, single-throw switch stands between the two exciters.

For cleaning of the machine an air compressor is used. This stands in the basement with its pressure tank and pipes lead to hose bibs located in each generator pit.

Switchboard.—The main switchboard is of blue Vermont marble and contains two transformer panels, two double circuit feeder panels, one station panel and two blank panels. Each transformer panel which controls the low-tension side of two banks of transformers has two 2,400-ampere ammeters with plugs for reading any phase, two power factor meters, two 2,400-ampere, 2,500-volt polyphase indicating wattmeters and two control switches and indicating lamps for operating the automatic circuit-breakers to transformers.

Upon each of the outgoing line panels there are mounted six 400-ampere ammeters, two control switches with indicating lamps for operating the high-tension transformer switches, and two control switches with lamps for operating the high-tension line switches.

The station panels support two graphic recording voltmeters, one high-tension bus sectionalizing oil switch control handle, one low-tension bus sectionalizing oil switch control handle, and four double-pole, single-throw, 100-ampere switches with fuses. The latter switches are for the control of the station lighting, current for which is supplied by the exciters. The switchboard is very satisfactorily lighted by means of a Frink window reflector placed above and slightly to the front of the board.

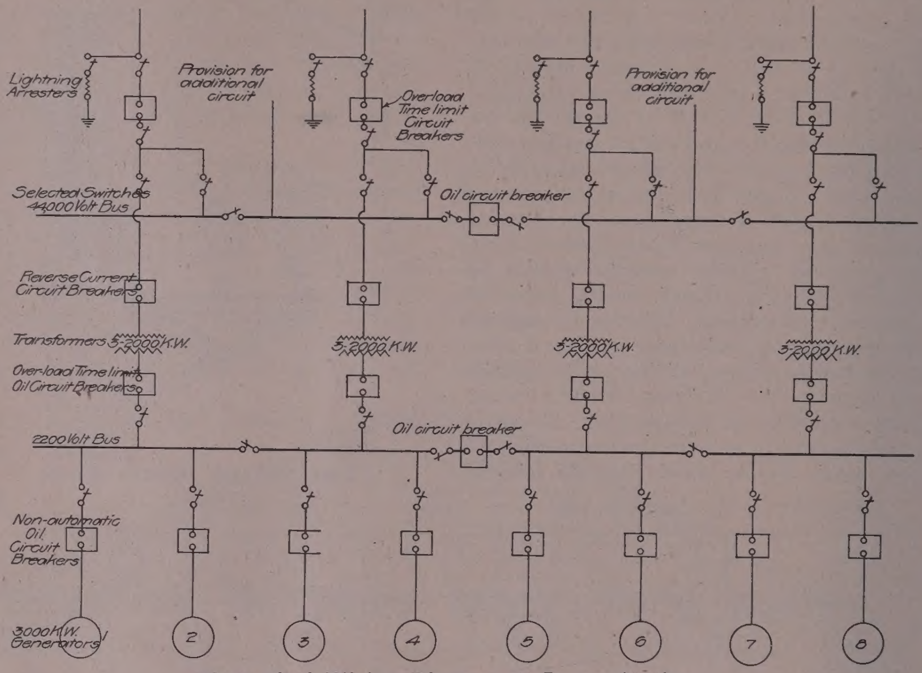
In the cable conduit, shelves have been built along the side walls, and along these are laid the exciter bus bars, the generator field leads and the power leads. The shelves were formed by building into the concrete walls sheets of ferro-inclave 12 in. wide, and, after setting, these were plastered top and bottom, while wooden bars spaced some 10 ft. apart are fastened across the shelves to prevent the possibility of jumping out of the cables. The exciter leads and the power leads are carried from this conduit to the generator pits through vitrified conduit manufactured by the American Vitrified Conduit Co. The cable layout is such that the exciter leads and the power leads are entirely separated, being carried on opposite sides of the conduit. The exciter bus bars are placed along the curved wall, being as close to the exciters as it was possible to place them.

There are two sets of exciter bus bars, but on account of their location a paralleling switch could not be operated from the switchboard platform. To compensate for this the main exciter leads were connected through double-throw switches to each set of bus bars, so that both machines could be operated in multiple on either set of the bus bars. The generator field switches are double-throw to each set of bus bars and are provided with auxiliary blades so that in case the exciters are operated separately, and it is desired to change any generator field to the other bus bar it is only necessary after adjusting the exciter voltage to throw the auxiliary blades and then the main switch.

The 1,400,000-c.m. lead-covered power cables pass from the conduit into the basement beneath the transformers, and on shelves along the piers which extend through this floor to points opposite their respective generator oil switches, and here curved recesses have been molded into the piers, into which the cables are bent, being carried thence diagonally upward to the switches. Lead-covered cables are used throughout for generator field leads, generator main leads and the low-tension leads from the oil switches to transformers.

Switches.—The low-tension bus and oil switch structure is built up of concrete slabs and steel framing. The oil switches are contained in the cells of the substructure, and the bus bars are carried in compartments built above these and around three sides. A gallery of structural steel and concrete provides accessibility for the operation of the selector switches.

A sectionalizing oil circuit-breaker cuts the bus bars into two sections, and by means of the selector switches mentioned each section may be further divided. It is therefore possible with this arrangement to operate in multiple the entire equipment, half of it or any pair of generators. Bus bars are made up of five strips of copper clamped together, each strip being ¼ by 3 in. They are connected to the low-tension side of the transformer through automatic oil circuit-breakers, the connection consisting of two 1,000,000-c.m. lead-covered cables per phase.


Lightning Arresters
Provision for additional circuit
Overload Time limit Circuit Breakers
Provision for additional circuit
Selector Switches 44000 Volt Bus
Oil circuit breaker
Reverse Current Circuit Breakers
Transformers 3-2000 K.W.
3-2000 K.W.
3-2000 K.W.
3-2000 K.W.
Overload Time limit Oil Circuit Breakers
2200 Volt Bus
Oil circuit breaker
Non-automatic Oil Circuit Breakers
3000 K.W. Generators
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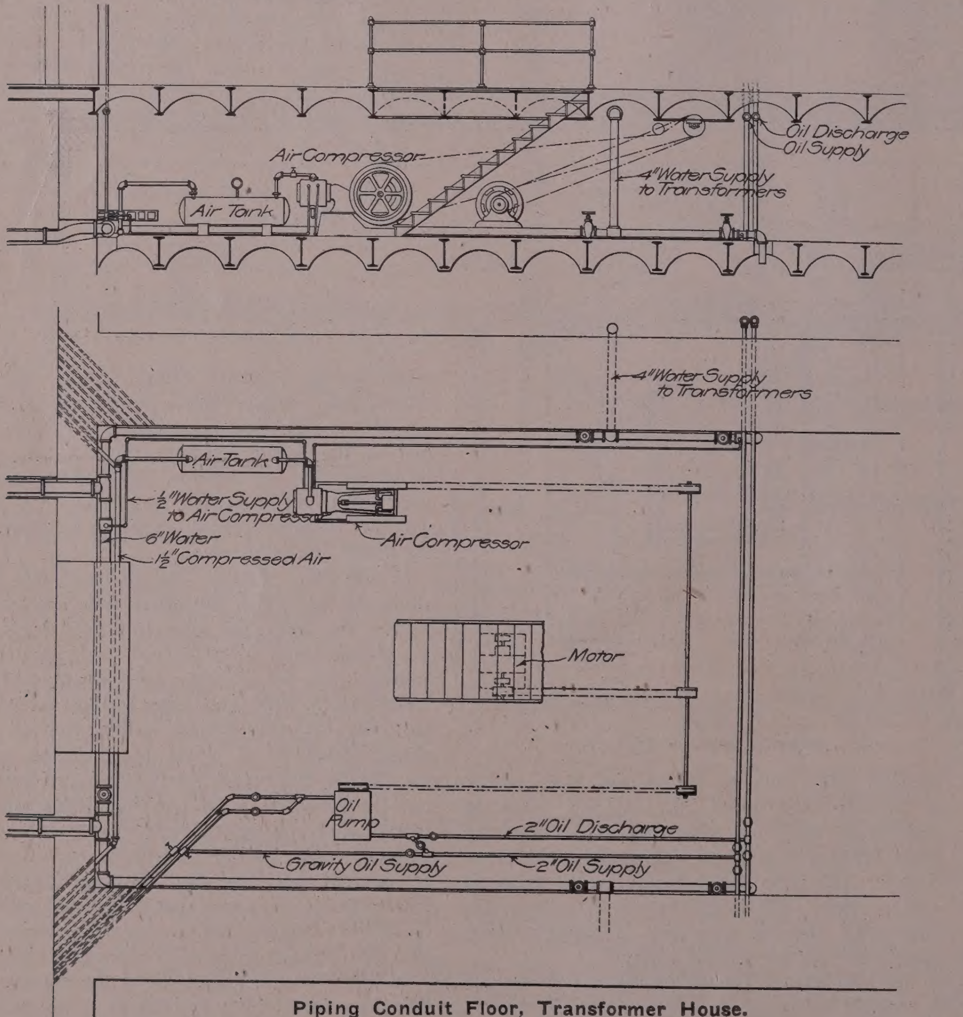
Theoretical Wiring Diagram of Power Station.



Piping Conduit Floor, Transformer House.

For the bus bars on either side of the junction switch there is furnished a 2,200-volt ground detector mounted on the bus structure. Shunt transformers for meters are hung on the walls and beneath the gallery, while the series transformers are placed between soapstone barriers behind the oil switches. All control leads drop down through the floor to the basement whence they are carried to the switchboard in 1-in. pipes, which are suspended from the ceiling beams.

Leads from the high-tension terminals of the transformers are taken through a well in the floor of the second story, where they connect through oil switches either to high-tension bus bars or feed directly into the line. Here, again, flexibility of control is secured by an arrangement of selector switches, whereby any bank of transformers may be operated or thrown on the bus bars for multiple operation. Current for operating all high-tension circuit-breakers is obtained from oil-insulated series transformers. All high-tension wires and bus bars consist of 1-in. copper tubing. The selector switches and bus bar insulators are supported on a steel structure of latticed girders.

In order partially to relieve the transformer windings of the excessive strain due to surges in the line, choke coils of the oil-insulated type are placed between the transformers and their respective high-tension bus oil switches. The lightning arresters are of the single-pole, low-equivalent type, for which the manufacturers claim great efficiency both as to the prevention of rise of potential on the line and the suppression of the arc after the discharge. The complete electrical equipment was furnished by the Westinghouse Electrical & Manufacturing Co., of Pittsburg.

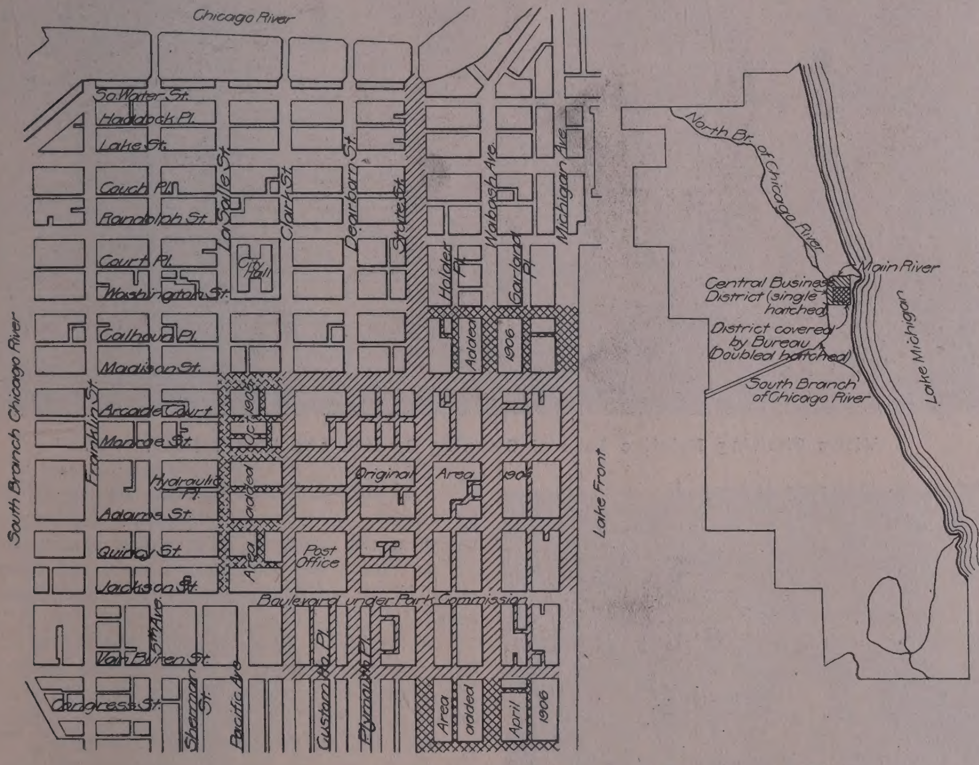
The outgoing lines are taken through a 2-inch hole in a 36x36-in. full-segment top polished plate glass window ½ in. thick. An angle iron bracket supports the insulators on the outside of the building.

(To be continued.)

Evaporation Experiments exceeding in importance any ever undertaken before will shortly be begun under the joint direction of the United States Geological Survey, the United States Weather Bureau, and the United States Reclamation Service. The inundation of the Imperial Valley in Southern California by the break in the banks of the Colorado River, forming the Salton Sea, is well known. The break has now been repaired and the sea will slowly evaporate. In some places the water rose to a depth of about 80 ft. and covered a large area. The water which remains can readily be measured and accounted for, and in order to determine the evaporation it will merely be necessary to observe the rate of recession of this great lake and to take account of the attendant climatological phenomenon. The chance for decisive work along this line offered by this sea is one that can hardly be expected to occur again.

Street Cleaning in the Central Business District of Chicago.

Street cleaning results in Chicago on the whole have always been open to serious criticism, and, when considering the class of traffic tributary to them, the streets in the principal business areas of the city have suffered more from lack of proper attention than any others. With a desire to improve the condition of the streets in the central business district of the city, the Commercial Club and the Merchants' Club, two organizations formed to forward the interests of the city at large, organized a Citizens' Street Cleaning Bureau in June, 1904. The results that have been secured since then by this bureau are remarkable, as the streets covered by its forces have been kept clean at all times, although the street pavements in the district have remained the same as they were before the bureau started operations.



Maps of District Cleaned and of Location of District in City.

The area now covered by the bureau embraces 56 city blocks, with the corresponding streets and alleys, which include 128,900 sq. yd. of street surface and 18,000 sq. yd. of alley surface, making 4.9 miles of streets and 1.7 miles of alleys. The bureau receives from the city the funds which were estimated by the municipal officials would have been spent for street cleaning in this district according to old methods. The remainder of the expenses of the bureau are supplied by tenants and property owners in the district, and from these men the necessary executive officers and a board of directors are elected. This method of providing for street cleaning on such a large scale by a private organization of this kind is believed to be unique, in this country at least. The standing of the subscribers to the bureau may be judged by the following personnel of the board of directors: Franklin MacVeagh, Franklin MacVeagh & Co.; Ogden McClurg, A. C. McClurg & Co.; C. D. Peacock, C. D. Peacock & Co.; Charles Gunther; W. C. Thorne, Montgomery Ward & Co.; J. L. Kesner, The Fair; Robert Mandel, Mandel Brothers; Louis Ferguson, Chicago Edison Co.; W. Juergens, Juergens & Andersen; Bryan Lathrop, Commissioner Lincoln Park Board; J. T. Pirie, Jr., Carson, Pirie, Scott & Co.; Frederic McLaughlin, W. F. McLaughlin & Co.; Louis Stummer, Stummer, Rosenthal & Eckstein; Frank Macomber, Hibbard, Spencer, Bartlett & Co.; W. S. Gould, Tribune Building; R. M. Winans, Spaulding Co.; Vernon Booth, A. Booth & Co.; Elmer Schlesinger, Moran, Mayer & Meyer; James Simpson, Marshall Field & Co.; and David Forgan, president National City Bank, treasurer.

The operations of the bureau are under the supervision of Mr. Richard T. Fox, general manager, who was formerly connected with the street cleaning department of New York City, and was under the late Col. Waring, of that department. An inspector immediately in charge of the foremen of the sections into which the area covered is divided, reports to the general manager. The sections are further divided into 64 sweeping routes, the area of each of which depends on the width of the street, the kind of pavement, the density of traffic, and so forth. A man sweeping by hand is assigned to each of these routes which vary from ½ to 2 blocks in length, this man being held to account for the cleanliness of his route. The sweepers are uniformed and numbered and each man has a space at headquarters for his uniform and tools. To avoid confusion and to fix responsibility for the care of the bureau property this space and each particular implement in the sweeper's care bears his number. The bureau also has its own teams and wagons for hauling sweepings to the dump, the drivers of these teams being uniformed and numbered the same as the sweepers.

The number of sweepers at work and the route covered by each man is followed from the office each day by a special system of checking. A board carrying a large scale map of the district with the different routes shown, and a lot of thumb tacks each having a number on the head, are provided. When the men report in the morning a tack bearing the same number as the number on the cap of the sweeper covering each route is placed on the map. If any men quit work during the day, the office is notified and the tacks on their routes on the maps are removed. In this manner it may be seen with a glance at the map whether any routes are not covered.

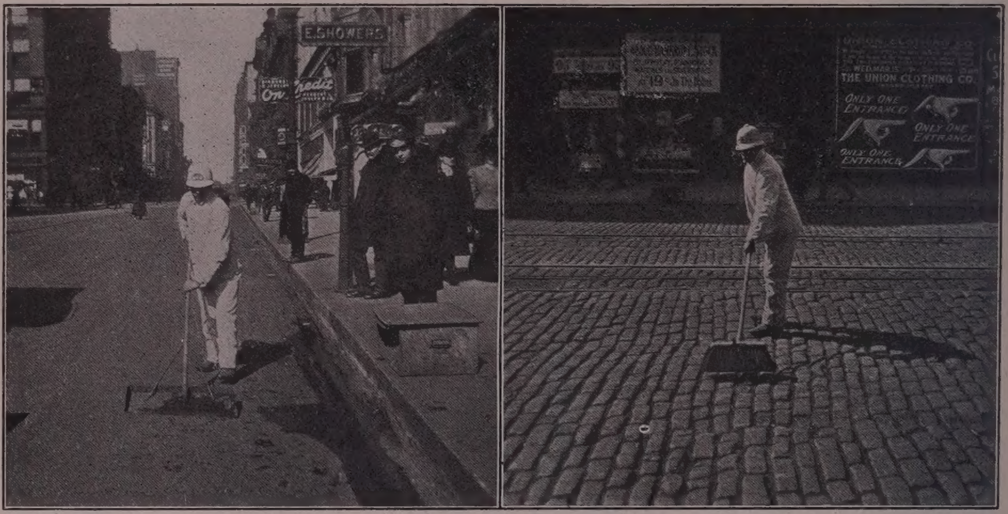
The foremen make written reports daily of the number of men employed, the route swept by each man, the number of teams at work, the yards of refuse removed and the condition of their sections at quitting time. The team reports cover the time required to make each round trip, including the time of collection and the return from the dump, and give the number of yards of refuse hauled at each load. If for any reason a street or a portion of a street is not thoroughly cleaned, or if any sweepings are left in the gutters at quitting time, these facts must be noted and explained in the foreman's report. No excuse short of a circumstance entirely beyond the control of the inspector and foreman is accepted for either of these conditions. Failures to perform work assigned, or other delinquencies are reported on a blank form with the name and number of the sweeper or driver concerned, and a recommendation, not to exceed the punishment proscribed in a published code or rules, as to the disposition of the case is forwarded to the office of the general manager for final action. The daily reports are checked by the inspector who forwards them every morning with his own report covering the entire district to the office of the general manager. From these reports and from an inspection of the streets, the general manager is enabled to keep in close touch with the most minute details of the work.

A daily statement showing the cost, by sections, of the previous day's work is made out and by noon each foreman knows the cost of the work done under his direction as compared with that of the other foremen. The effect of this arrangement is to create a spirit of competition and rivalry with a consequent beneficial influence on the character and cost of the service. The daily expense reports are made out by the inspector and are approved by the general manager. They cover the cost of supervision and of labor for the sweeping and the cost of supervision, labor and teams for the carting, the cost of administration, office and miscellaneous expenses being proportioned at the end of longer periods.

The streets are swept thoroughly every day, on an average of two and a half times each week day and once on Sundays. The sweeping is done entirely by hand, which is, of course, a more thorough and effective method than machine sweeping on the uneven pavements of the district covered. The hand cleaning can also be done during the day when it is most essential that the streets should be in good condition. The pavements are swept from the middle of the street either way to the curb. The sweepings as they are gathered from the street surface, are deposited in metal boxes placed along the curb edge of the sidewalk, for temporary storage between the rounds of the wagons, which are made from time to time during the day. These boxes have a handle on each end and are covered with a hinged lid. They hold about 4 cu. ft. of sweepings and are placed at various intervals along the street depending on the amount of sweepings obtained from the block. Although these boxes do not add to the appearance of the street and interfere to a slight extent with the free use of the sidewalks, their use is far preferable to the practice of piling the sweepings in the gutter to be scattered by traffic, blown about by the wind or washed along the gutter by a sudden shower.

A number of conditions combine to make street cleaning in Chicago and particularly in the district covered by the bureau, difficult and expensive. There are a number of features which influence the cost of street cleaning in business sections of this kind, the principal ones of which are the kind and condition of the pavement, density of traffic, character of population, dirt spilled by wagons, building operations, pres-

Refuse Collecting Cart.

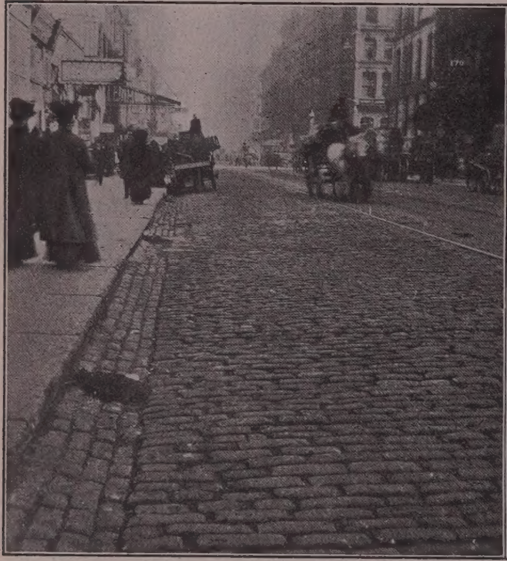


Views Showing Relative Ease of Cleaning Smooth and Rough Pavements.

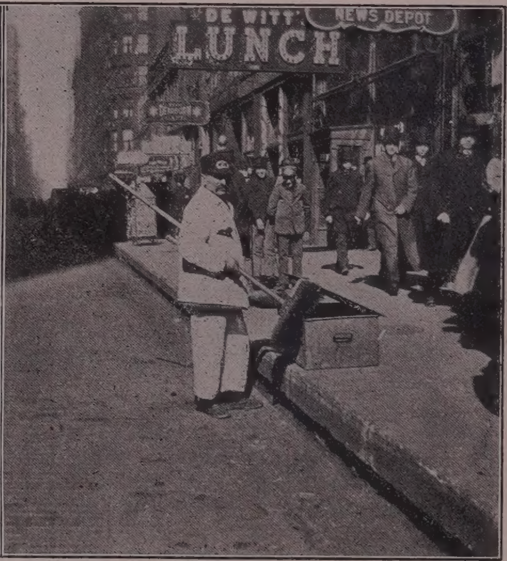
ence or absence of car tracks and so forth. Chicago being built on flat, swampy land, requires that street pavements be placed on stable and impermeable foundations if they are to be kept even and smooth so they can be cleaned readily, while in reality few such foundations have been provided in the district in which the bureau operates. Besides, the location of the district is such that it receives in addition to the large volume of comparatively light traffic tributary to such a business section, a great amount of heavy cross town trucking. Furthermore, several of the other features which influence chiefly the cost of street cleaning are noticeably adverse in the streets of this section.

The pavements in the district covered by the bureau are about 85 per cent. granite block, the remainder being asphalt, except one block of brick pavement. In practically all cases the granite blocks are laid on the soft natural soil or on sand. The spaces between the blocks were originally filled with gravel and cement, or tar, but repeated disturbances of the paving by public utility companies, and by others, and the constant pounding of heavy traffic has loosened much of this filling, which as such has disappeared, allowing the sand or earth to work up through the joints. During dry weather this dirt is converted to dust; in wet weather it forms mud. In cleaning where such conditions exist, the dirt is kept considerably below the surface of the paving blocks by digging it out and by sweeping from the middle of the street either way along the joints to the curb. The quantity of mud formerly carried by wagons to the cross walks and then, by pedestrians, to the sidewalks and into the buildings has been greatly reduced by this method of cleaning. The dirt from this source is in such proportions as to make the pavement noticeably uneven. Since this dirt cannot be separated, however, from that produced by other sources in the same block the exact quantity of it can only be estimated. It has been determined by the experience of the bureau, nevertheless, that with the same traffic, a given area of granite block pavement produces an average of 36 per cent. more dirt than an equal area of asphalt. As a single comparison of the quantity of sweepings obtained from granite block and from asphalt pavement seven blocks of State St. may be cited. A block at each end of these seven is paved with granite block; the other five blocks have asphalt pavement. The average quantity of dirt collected daily during a period of nearly a year from each of the blocks paved with granite was 1.5 cu. yd.; the average daily quantity from the asphalt paving was 1.1 cu. yd. per block of paving. Furthermore, two sweepers were required to each block of granite paving while three men cared for two blocks of the asphalt paving. Based on the results of two and a half years of operations, it is estimated that if the granite block paving in the district could be replaced by some smooth, impervious pavement, such as asphalt, the resulting saving would amount to 6 per cent. on the cost of the substitution of the smooth, impervious pavement.

If the granite blocks were carefully dressed, then placed on a concrete base, and the spaces between them filled properly, Mr. Fox considers this class of pavement would not cost more to keep clean than a brick pavement similarly laid. With the pavements as they exist in the district, however, the granite block paving costs 12 per cent. more than brick paving and nearly 50 per cent. more than asphalt to keep clean. The following data shows the comparison between the actual cost of sweeping granite block and asphalt pavements during 1906 in the district covered by the bureau: Fifty-three men were employed regularly in sweeping 91,742 sq. yd. of granite paving at a total average daily cost of $79.50, or $0.867 per 1,000 sq. yd. per day. Fifteen men were employed regularly in sweeping 37,158 sq. yd. of asphalt paving at a total average daily cost of $22.50, or $0.605 per 1,000 sq. yd. per day. This great difference in cost exists in spite of the fact that most of the asphalt pavement cleaned by the forces of the bureau is far from being in satisfactory condition; if it were free from fault and the surface smooth at all times the difference would be even greater than it is. If the granite block paving were replaced by asphalt, or some other smooth impervious pavement the saving in labor would amount to at least $24 a day, or $8,760 a year, and even more if the smooth pavement was free from holes.



Sweepings Piled in Gutter.



Box for Sweepings.

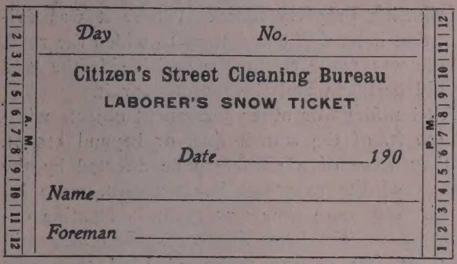
The conditions which produce the unusually large amount of heavy trucking on the streets in this district are somewhat peculiar. The district is surrounded on three sides by closely built up areas and on the fourth by Lake Michigan. The traffic between the three sides of the city is heavy, and a large part of it is required to pass across the central business district, owing to the location of bridges across the Chicago River and its branches, and of railroad yards. During the time the bureau has been in existence the street traffic toward the lake has also been heavy, as practically all the ashes, materials from building and trench excavations and so forth have been hauled to the lake front to assist in reclaiming a large area there that is to be utilized as a park. This traffic has been particularly objectionable from the street cleaning standpoint as much material is dropped from such wagons to the street.

A census of the traffic on the corresponding block of each of the main north and south streets in the district was made by the bureau in the latter part of February and the first part of March of this year, with a view of determining the effect of traffic tonnage on street cleaning. An observer was stationed in a second-story window in a building along each of these blocks and counted the number of vehicles passing the station between 6 o'clock in the morning and 6 o'clock in the evening. A careful estimate of the weight of the different vehicles, including horses and drivers, was made as follows: One-horse vehicle, light, 2,000 lb.; one-horse, loaded, 3,000 lb.; two-horse, light, 4,000 lb.; two-horse, loaded, 6,000 lb.; three-horse, light, 7,000 lb.; three-horse, loaded, 15,000 lb.; four-horse, light, 8,500 lb.; four-horse, loaded, 18,000 lb.; six horse, light, 12,000 lb.; horse and mount, 1,500 lb.; automobile, 3,000 lb.

TABLE I, SUMMARY OF TRAFFIC CENSUS ON VARIOUS STREETS.

Classication of Vehicles.	La Salle St. 48 ft. wide. Vehicles during day.	La Salle St. Tonnage per ft. of street width.	Clark St. 48 ft. wide. Vehicles during day.	Clark St. Tonnage per ft. of street width.	Dearborn St. 48 ft. wide. Vehicles during day.	Dearborn St. Tonnage per ft. of street width.	State St. 60 ft. wide. Vehicles during day.	State St. Tonnage per ft. of street width.	Wabash Ave. 60 ft. wide. Vehicles during day.	Wabash Ave. Tonnage per ft. of street width.
1 horse light......	1,613	33.8	808	18.0	1,106	23.2	1,782	28.0	806	13.4
1 horse loaded.....	1,272	40.0	743	23.4	875	27.6	1,427	35.6	611	15.3
2 horse light......	564	23.6	169	7.1	292	12.3	974	32.4	264	8.8
2 horse loaded.....	919	57.5	324	20.5	522	32.6	1,309	66.0	468	23.4
3 horse light.......	27	2.0	5	0.4	35	2.6	21	1.2	22	1.3
3 horse loaded.....	23	3.6	8	1.2	54	8.4	44	5.5	23	2.9
4 horse light......	16	1.9	0	0.0	3	0.3	6	0.4	1	0.0
4 horse loaded.....	19	3.1	0	0.0	0	0.0	14	2.1	2	0.3
6 horse light.......	0	0.0	0	0.0	0	0.0	2	0.2	0	0.0
Horses mounted or led...............	12	0.2	32	0.5	31	0.5	52	0.6	15	0.2
Automobiles	182	5.7	36	1.1	67	2.1	333	8.3	96	2.4
Totals...........	4,649	171.4	2,125	72.2	2,985	109.6	5,964	180.3	2,308	68.0
Total tonnage...	8,217		3,465		5,260		10,818		4,080	

A summary of the various census is given in the accompanying Table 1, from which it may be noted that the heaviest total tonnage is on State St., amounting to 180.3 tons per foot of street width per 12 hr. La Salle St. is next in order both in total traffic and in tonnage per foot of street width, while Clark St. is lowest in total traffic, and Wabash Ave. in tonnage per foot of street width. With the exception of the block on La Salle St. all of the streets have two street car tracks, and Wabash Ave. also has two rows of columns supporting the structure of the elevated railroad, so the amount of tonnage per foot of street width is very much more concentrated than is indicated by the table. It may also be observed from the table that 8,124 horses passed along State St. and 6,153 horses along La Salle St. during the 12 hr. the census was being made in each case. This tremendously heavy traffic, with the correspondingly large number of horses and a considerable portion of loads such as ashes, dirt and so forth, which contribute to the materials to be removed from the streets, render street sweeping in the district particularly expensive.


A. M. 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12

Day No.________

Citizen's Street Cleaning Bureau

LABORER'S SNOW TICKET

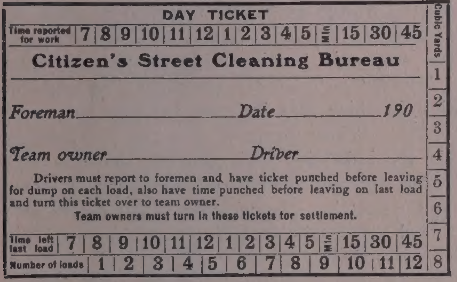
Date__________190

Name__________

Foreman __________

P. M. 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12

Laborers' Ticket for Snow Removal.


DAY TICKET

Time reported for work	7	8	9	10	11	12	1	2	3	4	5	6 M	15	30	45

Citizen's Street Cleaning Bureau

Foreman__________ Date__________190

Team owner__________ Driver__________

Drivers must report to foremen and have ticket punched before leaving for dump on each load, also have time punched before leaving on last load and turn this ticket over to team owner.

Team owners must turn in these tickets for settlement.

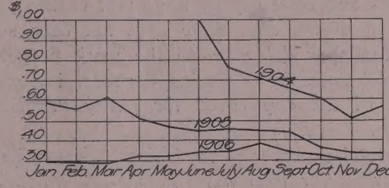
Time left last load	7	8	9	10	11	12	1	2	3	4	5	6 M	15	30	45
Number of loads	1	2	3	4	5	6	7	8	9	10	11	12			

Cubic Yards 1 2 3 4 5 6 7 8

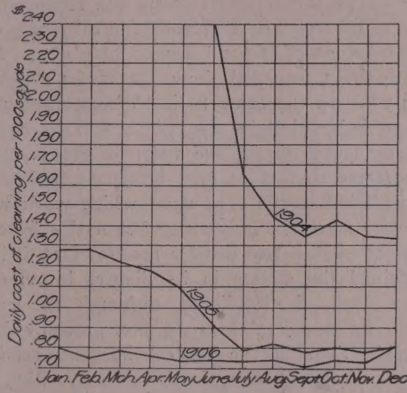
Team Ticket for Snow Removal.

In order to show the influence of the traffic tonnage on the cost of street sweeping on the various blocks covered by the census, let 1 represent the traffic tonnage on the block on Clark St., which carried the smallest amount recorded. Then 1.2 would represent the traffic on the block on Wabash Ave., 1.5 that on the block on Dearborn St., 2.3 that on the block on La Salle St., and 3.1 that on the block on State St. As a matter of fact, one man is employed to the block on Clark St., 1.2 sweepers to the block on Wabash Ave., 1.5 sweepers to the block on Dearborn St.; 2 sweepers to the block on La Salle St., and 1.5 sweepers to the block on State St.

Other things being equal, it will be noted that the number of men and consequently the cost of sweeping varies directly as the tonnage of traffic. The block on State St. has only 1.5 sweepers to the block, while the amount of traffic would call for 3.1 sweepers per block. This apparent discrepancy is accounted for by the fact that the block of State St. is paved with asphalt, while the other blocks on the other streets are paved with granite blocks, showing the saving due to the smooth pavements.



Comparison by Months of Cost per Cubic Yard for Removal of Street Sweepings.



Comparison by Months of Cost per 1,000 Sq. Yd. of Paving Swept Daily.

The amount of preventable dirt and litter, such as newspapers, wrapping paper, paper boxes, fruit skins, excelsior, straw, sweepings from sidewalks and buildings, slops, ashes, materials from building and trench excavations and so forth, is astounding. Much of what may be classed strictly as litter is contributed by the pedestrians, and the amount of it depends largely on the number of pedestrians. Iron boxes for receiving this litter have been placed at frequent intervals by the city, which boxes, together with proper ordinances, have reduced this nuisance to some extent. As it is, however, one man is employed solely in collecting litter in the alleys of the district covered by the bureau, and the time consumed by the whole body of sweepers in gathering litter from the streets is estimated to amount to the entire time of three men. There is, therefore, $180, exclusive of cartage, expended per month in the district on this account.

With the exception of a few blocks, the streets cleaned by the bureau have two street car tracks which carry a large volume of traffic. The presence of these tracks makes sweeping more difficult, and the large number of cars on the tracks adds to this difficulty.

The high winds which prevail during a good part of the year in Chicago have a noticeable influence on the expense of cleaning streets in the district covered by the bureau. The wind scatters the dirt about the street before it can be collected, and also blows much dirt on the streets in this district from streets in adjacent districts where cleaning is not so carefully done.

A comparison by months of the cost per 1,000 sq. yd. of paving swept daily since the organization of the bureau is given in one of the accompanying diagrams. The great reduction in cost at the start and the following gradual reduction during the first year were due to the fact that the entire force of the bureau, consisting of an inspector, 3 foremen and 85 sweepers, was inexperienced at first, none of the men having any knowledge of street cleaning. The remarkably uniform cost of sweeping during 1906 is noticeable, the average for the year being 75 cents per 1,000 sq. yd. per day, swept two and one-half times a day on the average. Laborers were paid at the rate of $1.50 for an 8 hr. day during this period.

The cost of removing sweepings from the streets differs from ordinary hauling in that it requires considerable time to stop at each box in which the sweepings are stored temporarily along the edge of the sidewalks, and to empty the contents of the box into the wagon, covering in the meantime a mile or more to secure a load. It also differs from ordinary hauling in that two men are necessary to each wagon. The sweepings have heretofore been hauled to the lake front park site, the average haul being about one mile one way. On the average, over 1,700 cu. yd. of refuse are hauled away from the streets of the bureau's district each month and about 275 cu. yd. from the alleys. The average cost of collecting and hauling this refuse under these conditions was a trifle less than 33 cents per cubic yard during 1906. A team, driver and helper cost $6.50 a day, the wagon holding 5 cu. yd. The reduction that has been made in the cost of hauling this refuse since the inception of the bureau is shown in an accompanying diagram, the great reduction at the start being explained the same as in the case of the cost of sweeping.

The removal of snow from the streets in the district covered by the bureau's forces is also handled by the latter. In event of a snow fall the regular men begin to sweep the snow into piles along the curb where it is out of the way of traffic. If the fall of snow promises to be heavy, extra men are employed to assist the regular men. In the meantime the team owners have been notified and as quickly as teams report the work of removal starts and is continued uninterruptedly, day and night, until the streets are clear. The promptness with which the snow is removed is dependent on the number of available teams. The temporary character of the work, which is also confined to the small area covered, is not a sufficient inducement for a team owner to make special arrangements for it, so dependence can be placed only on the number of teams that happen to be idle at the time.

The uncertainty as to the time of the arrival of the snow, the depth of fall, the accompanying temperatures and the number of teams available make snow removal a transportation problem very much out of the ordinary. The teams are paid by the yard of snow hauled, rather than by the day, as an incentive to have each team make as many loads a day as possible and so hasten the work. The rate of pay is 15 cents per yard, the price being based on a 5-yd. wagon at $4.50 per day, which requires six loads, the average number made by wagons so engaged. The teams paid in this manner remove, however, as high as ten loads per 10-hr. day on hauls of three-quarters of a mile each way.

When a wagon reports on the work it is measured and its yardage computed and entered

Table 2, A Comparison of Funds Available and Expended for Street-Cleaning Purposes in Various Cities.

City.	Population, thousands.	Area square miles.	Paved streets sq. yd.	Property tax receipts per capita.	Tax per $1,000 real valuation.	Aver. annual appropriation for street cleaning per mile.
New York	3,888	326	31,830,832	$20.13	$15.17	$2,100
Chicago	1,932	190	26,618,000	10.11	6.06	207
Philadelphia	1,392	129	18,673,103	12.79	14.50	551
St. Louis	624	61	11,363,077	14.65	14.14	926
Boston	538	43	9,223,886	29.84	14.47	953

on a blank form together with the names of the owner and driver. As soon as the wagon is loaded the driver reports to the foreman, who inspects the load, notes the number of yards, punches this number in the margin of a ticket printed specially for the purpose and after recording on his report the number of the ticket opposite the driver's name, presents the ticket to the driver as a tally of the indebtedness of the bureau for so much snow. Each foreman has tickets of a distinct color and series. The punch marks of the various foremen also differ, so that in cases of dispute, lost or stolen tickets, attempts to change the face of the ticket or any dishonest work the ticket involved can be traced through the owner, driver and foreman to the day or night and approximately to the hour when it was issued.

The extra laborers required during snow removal are given a ticket each day, and as a check on their time these tickets are punched at intervals during the day. The implements which the extra men take from headquarters are also noted on the ticket and are checked in at night, the holder of the ticket being responsible for any tool he fails to return.

The snow is hauled to the lake front fill and dumped. A man stationed at the dump punches the drivers' tickets after the loads are dumped and notes that the drivers do not carry any snow back, which would enable them to save time in securing the next load. The loading foreman also inspects each wagon on its return from the dump to prevent the same practice.

During the first winter the cost of snow removal was on an average 27 cents per cubic yard during the second winter this cost was reduced to 25½ cents, and during the winter just past, it was only 24 cents per cubic yard, these costs in each case including the loading, hauling and dumping. The total expense in round numbers for snow removal in 1906 was only $3,470, as compared with $12,656 the winter previous. The total snow fall in 1905 was 29.6 in., and the average temperature was 32° Fahr., while in 1906 the total snowfall was 20.9 in. and the average temperature 36° Fahr., which accounts for the difference in cost to a large extent.

That the funds devoted to street cleaning, exclusive of garbage removal and disposition, by the city of Chicago are much below those expended for such work in other cities is well illustrated by the accompanying Table 2, showing a comparison of the streets cleaned and funds available in the six largest cities of the country.

The figures given are for the year 1904 and are the latest to be obtained for purposes of comparison between the different cities. From the table it may be seen that while Chicago had only about one-half the population of New York, it had 83 per cent. as many square yards of paved streets. On the other hand, the property tax receipts per capita for Chicago were only one-half those of New York, while the rate of taxation for property per $1,000 of real (not assessed) valuation was only $8.06 in the former, as contrasted with $15.07 in the latter city. In 1904 New York expended in round numbers $3,800,000 in cleaning its streets, while Chicago used only $300,000. The average street-cleaning appropriation per year per mile of pavement in the former city was $2,100, and in the latter only $207.

In comparing the figures for Philadelphia, St. Louis and Boston with those of Chicago, it will be seen that the tax rate per $1,000 of real valuation and the receipts per capita from taxation were much lower for Chicago than for any of the other cities. It is also evident that the funds appropriated in Chicago for street-cleaning purposes were by far less per mile of pavement than any other city of the six, the amount being less than 10 per cent. of that for New York and only 30 per cent. of what Philadelphia expends. It is probable that if Chicago had as much money to spend on its streets per mile as most of these other cities, it could keep them all in excellent condition. Laying aside for the time being the methods and efficiency of the street cleaning department of the city, there have not been sufficient funds available to do the work properly; hence the necessity of having the more important streets of the city cared for partly at private expense.

The total expenses of the Citizens' Street Cleaning Bureau for 1906 were $59,546, of which $3,470.95 were used for snow removal. The city furnished $36,000 of this amount and the balance was made up by subscription among the tenants and property owners who furnished funds to help defray the expenses of the bureau. The bureau has recently been awarded the contract for the ensuing year on the same basis as heretofore, and it is probable that its operations will be somewhat extended during the year, as 32 per cent. more street surface is now being covered than was included in the area upon which work was originally started. It is evident that this bureau has accomplished two definite results: first, it has maintained the streets in its district in an excellent state of cleanliness, although the conditions for keeping them so are probably less favorable than in the central business section of any other large city of this country, owing to the kind and condition of the paving and the great volume of traffic congested into a small area. Secondly, the bureau has established a standard of thorough cleanliness by which the street cleaning of the whole central business district, and to an appreciable degree, of the entire city, is gauged.

Tall Concrete Towers have been built by the West Penn Ry., at a 1,014-ft. crossing of the Monongahela River by its transmission line. The main tower rises 115 ft. above its foundations as close to the river bank as practicable, and was designed to take a maximum load only of the wind stress on the tower itself and the weight of the wires. A shorter tower was then built about 230 ft. back of the main tower, and the transmission cables were brought down to anchor upon it. On the other side of the river the cables were anchored at a local sub-station. Both structures are self-supporting. The main tower is 8 ft. 2 in. square at the base and has a uniform batter up to the top where the section is practically 1 ft. square. The lower portion is hollow, with walls 1 ft. thick up to an elevation 84 ft. above the base, where the remainder of the section becomes solid. The anchorage tower is 4 x 10 ft. at the base, is solid throughout and batters up to a section 1 ft. square at an elevation 41 ft. 1 in. above the base. Above this point it is of uniform section up to its full height of 55 ft. Both towers are reinforced with old rails. A detailed description of the structures was recently contributed to the "Cornell Civil Engineer," by Mr. F. W. Scheidenhelm, of the railway company, who designed and constructed them.

Methods of Surveying on New York State Roads.

Toward the close of his term of office as State Engineer of New York, Mr. Henry A. Van Alstyne issued a manual of instructions to his staff engaged on highway improvements, which gives a comprehensive statement of the methods which experience up to that time indicated to be best suited to secure satisfactory results. So far as the surveys are concerned, these were based on transit lines, following in general the line of the existing highway. The azimuth of each line was taken and each transit point referenced to as permanent objects as possible, by at least three measurements.

The offsets to the existing fences and all other measurements of the survey within the right of way were made with sufficient accuracy to show the true location of the objects within the nearest foot. Walls, fences or other objects which indicate the boundaries of the road or of abutting property were located and the name of the owner of abutting property noted. Where it was evident that it would be necessary to widen the road, a note was made stating on which side the land should be taken and the reasons for it.

All buildings or other permanent objects within 100 ft. of the transit line, or beyond 100 ft. if they were of a nature to be affected by the details of the proposed improvement, were located. No more time was spent in locating objects beyond the fence lines or beyond the probable location of the improved road than was necessary to ascertain their approximate size and location, and all dimensions of such objects were estimated in the field and recorded at once in the notes.

The magnetic bearing of each property line and intersecting highway boundary line and the station at which they intersect the base line were recorded. Where property lines or intersecting roads are indefinite, their apparent location was recorded and not left for the draftsman to locate from the sketch. The location of all drives was recorded and a tabulated list made showing their character—whether house, barn or field entrance.

Existing paved ditches, curbing, catch-basins, railroad tracks, lines of telegraph and telephone poles and shade trees were located and the name of the company owning the tracks or poles noted.

All bridges were located and sketch elevations, showing the design of the abutments and superstructure, size of openings, etc., drawn in the back portion of the note book. Complete notes regarding the condition of both bridge and abutments were required.

All culverts were located and a tabular list, giving in each instance the station, size of opening, material of construction, length, condition and a recommendation regarding the proper size of new culvert, if one was necessary, was made in the back portion of the note book. In describing the condition of culverts but two classifications were used, "good" and "bad." When a culvert was described as "good," the understanding was that it was likely to meet all requirements for at least five years after the proposed improved road was finished. When a culvert was designated as "bad," the understanding was that it was likely to utterly fail within five years from the date of the completion of the road. If a culvert was designated as "good," and any additions or alterations were necessary, the engineer was required to make recommendations regarding it, and secure all data for preparing plans and estimates.

The approximate area of the watershed at each stream crossing was given, if it could be readily obtained, and a note made as to whether or not the water ever overflowed the road.

A tabulated list by stations of the nature of the soil was recorded in the back of the note book, and an entry made at least every 1,000 ft. whether or not the character of the soil changes. A thorough effort was made to determine the existence of unstable soil or places which were rendered unstable by water. Inquiry was made of highway officials and occupants of adjoining lands regarding spots that broke up badly in the spring and their location recorded.

Notes were made in the back of the note book regarding the location of quarries or outcrops of rock suitable for road material and masonry, the quality and quantity of the field stone in the vicinity of the road, the location of gravel pits, and the available places for procuring water for roller and carts.

Samples of available stone and gravel for each road were secured and forwarded with the survey books to the Division Engineer's office. All samples were marked plainly with the county, petition number, station, and name of the owner of the property where sample was obtained.

Information was also secured and recorded regarding distance to the nearest side-track or boat landing where stone could be delivered, and the name of railroad or waterway, the most advantageous locations for a crushing plant, prices of laborers and teams, and places where telford, gravel base, side drains, paved ditches or any form of special construction was needed. In general, objects located by cross-section measurements were not located by transit measurements, and vice versa. Elevations were referred to tidewater datum by connecting with a canal, railroad or geological survey bench mark, where this could be done at small expense; and check levels were run where existing bench marks were not found near each end of the survey. Assumed elevations taken from the U. S. Geological Survey contour maps were used where no better information was obtainable.

All elevations were taken to the nearest tenth of a foot, except the elevations of turning points and bench marks, which were taken to hundredths of a foot. A bench mark was established at least every 1,000 feet.

At each 100-ft. station, at each change of grade, and at crossroads, elevations were taken on the base line, and at such other points on either side of the base line as were needed to plot an accurate profile and cross-section of the road.

Usually the slopes beyond the fences were merely indicated, as: Down 1 in 10, level, etc., giving the approximate distance for which the rise or fall was continuous, but in all cases where there were cuts or fills on the existing road, where the road was narrow, or where there was a probability of heavy cutting or filling in improving the road, the cross-section was extended beyond the fence line as far as needed.

The location of the edges of the beaten track, the edge of sidewalk, line of trees, top of rail-fence line, and such measurements were shown in the cross-section notes by the use of letters written under the distance figures.

All elevations upon the outcropping rock were noted by the letter "R" under the distance figure; and at places where rock was near the surface, soundings or borings were made to determine the depth of overlying earth, the reading and distance figures being enclosed in a circle when recorded to denote a boring.

Cross-sections were taken where there were marked changes of grade at the sides of the road, even though there was no change in the beaten track.

Elevations of the ground, and of the bottom of sills were taken at the front corners of buildings where they were within 50 ft. of the base line, or beyond that distance, if a cut or fill on the improved road was liable to affect the buildings.

A cross-section was taken directly over each culvert showing the elevation of the road, top of cover, top and bottom of openings, and a profile up and down the ditch far enough to give the required information for draining from the new culvert usually placed lower than the old one. Wherever, in the opinion of the engineer in charge, new culverts were needed, he indicated their proposed location and size, and took a profile along the proposed location for an outlet. Where streams entered or left the highway at places not opposite culverts, their location was noted and a profile taken far enough up and down the stream to secure all information necessary in considering the advisability of planning a new drainage system. A cross-section was taken near each culvert in addition to the regular culvert section. This cross-section was for use in the computation of the regular earthwork, as well as the culvert excavation, and showed the general elevation of the road and land immediately adjoining the culvert and stream channel.

A survey party usually consisted of six men and divided to make a location squad and a cross-section squad.

The location squad, after establishing a zero station, located a line along the road by sighting forward at some well-defined object or at a flag set as a foresight. This line was then measured and all location measurements and notes made as the survey progressed. A temporary marker was placed at every station for the use of the cross-section squad. When the survey had progressed to a point where an angle became necessary or advisable, a permanent transit point was located by driving an iron pin at the end of some even foot. This was referenced, a new foresight taken, and the base line carried forward as before. The location squad took with a transit the azimuths of all lines run, and referenced them to the magnetic north line established at station 0. The magnetic bearing of each line was read and recorded as a check.

The members of the cross-section squad ran bench levels to determine the first height of instrument and then proceeded with the cross-sections. To avoid confusion a regular routine was followed in securing the rod readings and distances, and in calling the information to the recorder a common method being for the rodman to proceed first to the left, the instrumentman calling each reading, then the tapeman calling the distance, and then the rodman calling the nature of the point on which he held. On turning points after the instrumentman had called to the recorder the rod reading, the rodman checked the instrumentman's reading by sliding a card or slip of paper along the rod to the reading called, then holding the rod again for the instrumentman to observe. The rodman kept separate notes of rod readings on all turning points and bench marks and computed their elevations, and he kept the rod on each turning point until a back sight was taken.

Where a marked improvement in line or grade could be made, where the cost of maintenance in after years could be decreased, or where the grade of the old highway was so steep that a maximum grade of 7 per cent. could not be obtained with a reasonable amount of excavation and embankment, a new location of portions of the road was often advisable. When the engineer in charge of the survey party thought this was the case he promptly reported the facts to the division engineer, and unless receiving instructions to the contrary, proceeded to survey a new location along the most desirable route.

Surveys of a new location in general proceeded as on the old highway, except that in determining the proper alignment and grade, lower limits of curvature and percentages of grade were usually desirable and a somewhat greater expense was justifiable to secure this result.

It was considered impossible to fix limits for curvature or grades, for while 5 per cent. may, in a large portion of the State, be a proper limit for new location grades, the importance of most roads in mountainous regions will not warrant the expense necessary to secure this low limit. No new location, however, was run on greater than 7 per cent. grades, except by direction of the division engineer, and sharp curves and angles in alignment were avoided. In running a line on maximum grade several trial lines might be necessary to secure the best results and a profile was plotted in all cases before leaving the vicinity.

Cross-sections were extended farther on new location than on the old highway, especially on side-hill work, as it might be advisable to move the center line in preparing plans. Care was taken on new location work to secure the correct names of all property owners from whom land was to be acquired and, if necessary, the county records were consulted.

Swamps, woodland, pasture, cultivated land, vineyards, etc., were carefully noted and any data which could be obtained regarding cost of acquiring and clearing the land was noted.

Where a line for a new location was run so as to form a closed circuit with the base line in the highway, the azimuth of both the base line and the new location line was taken with a transit; and the fact that the circuit closed was ascertained before the field books were returned to the office.

Surveys for new right-of-way to be acquired were made by a party especially detailed for the purpose. The notes were placed in the original survey field book, if this could be done without confusion; if not, they were placed in a new book of standard form. The surveys were of two kinds: First, surveys of parcels of land along the sides of existing highways, and second, surveys of parcels of land where an entirely new location was proposed.

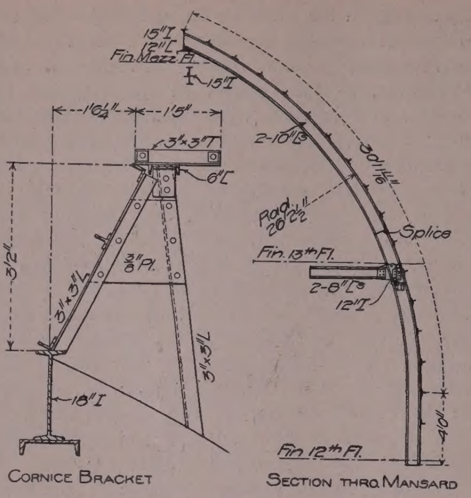
Plans and descriptions of parcels of land along the sides of the existing highway were prepared in the office from the data of the original survey, unless the parcel to be required was of such irregular shape as to make its computation difficult, in which case a survey of it was made in the following manner: An enclosing transit line was run around the piece of land along the new boundary line and the existing highway line. A magnetic bearing was taken at some angle where the needle was least subject to local attraction, and the bearing of all the sides calculated from this magnetic north, the needle reading of each line being taken and recorded as a check. The starting point of each survey was referenced to the base line by station number and offset distance, and also to any permanent reference point in the vicinity. The angle points, points of curvature and points of tangency of the new right-of-way line were monumented with 1-in. gas pipe rods 3 ft. long or some equally permanent monument. These were placed by the construction force when the right-of-way plan had been prepared from the data of the original survey.

In a survey where an entirely new location was made the center line of the proposed road, as shown on the plans was run in with a transit, using circular curves and their connecting tangents and following the line of the original survey except at such places as were modified in preparing the plans. Unless a greater width was advisable, the strip of land acquired on a new location was 60 ft. wide, 30 ft. on either side of the center line. Rods of 1-in. gas pipe 3 ft. long or some equally permanent form of monument were placed on the boundary lines of the land to be acquired at all angles, points of curvature and points of tangency.

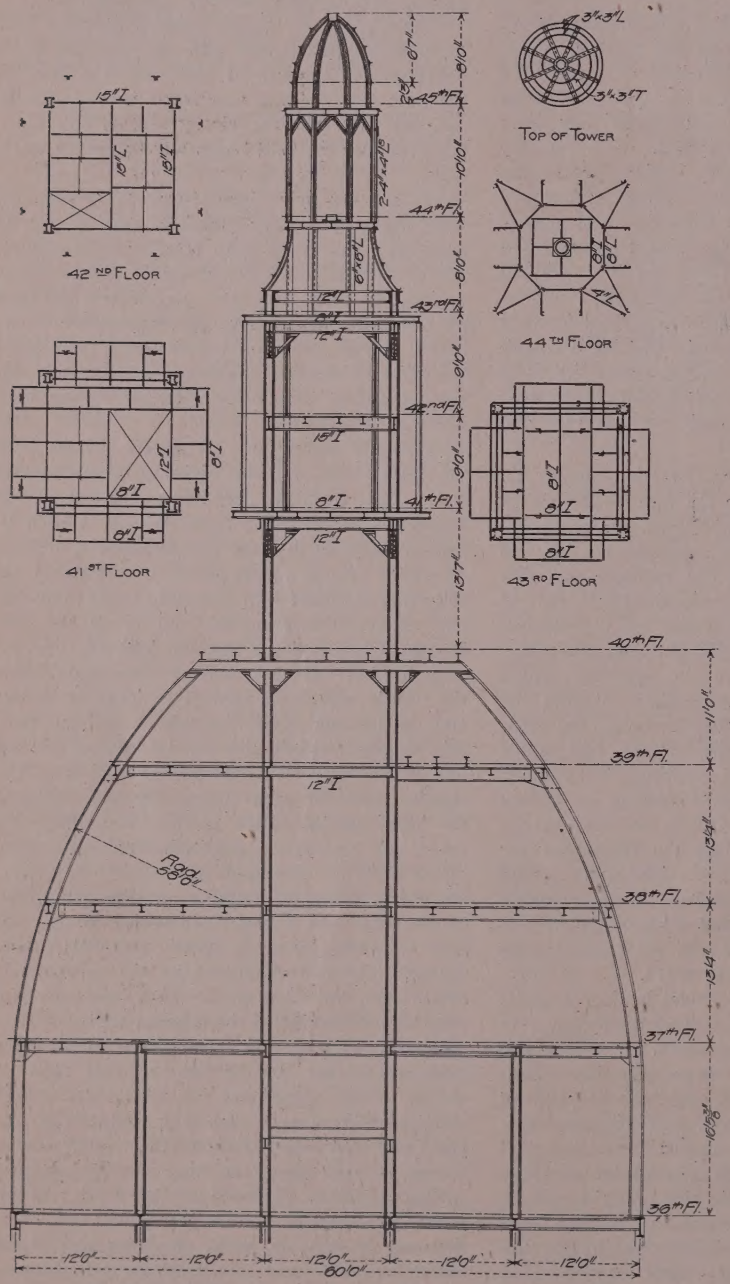
THE MAINTENANCE OF A ROAD 54 miles long in the Philippine Islands is carried on by 54 natives under the supervision of American foremen and a district engineer, at a cost of $400 per month.

Steel Details in the Upper Part of the Singer Building Tower.

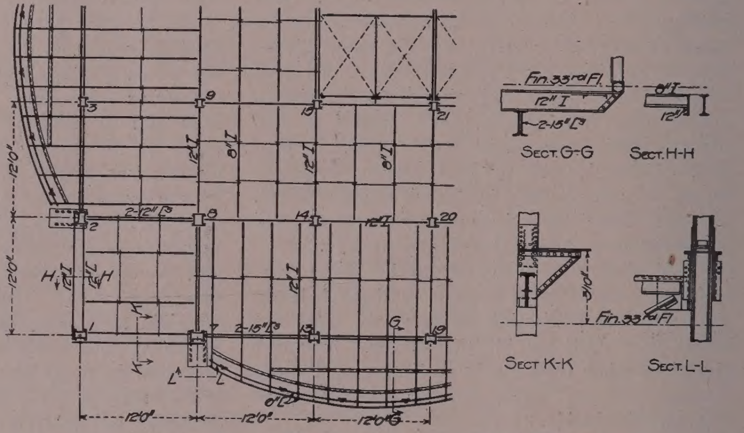
The 612-ft. tower of the Singer Building on lower Broadway, New York, is a 63x63-ft. steel cage rectangular structure with 36 steel columns seated on concrete piers extending to bed rock about 90 ft. below the curb and anchored to them to secure abundant resistance against the overturning moment of wind pressure. They extend continuously through the 14-story main building, forming an integral part of the frame work and are continued 320 ft. above its roof from a point about 190 ft. above the curb to the base of the spherical dome about 510 ft. above the curb. In 21 panels between these columns there are provided continuous X-bracing which virtually form vertical trusses reaching from the bottom to the top of the tower and acting as cantilevers to transfer the wind pressure to the massive foundation. These trusses together with the details of the columns and their anchorage connections were described in The Engineering Record of May 4 and 18, of the current year. The details of the upper part of the tower and dome will be illustrated in this article. The framework of the lower part of the tower corresponds to that of an ordinary steel cage building and is scrupulously fireproofed throughout with brick and terra cotta which encloses all portions of the structural steel. The floors all have flat hollow tile arches with cement finish and the walls are of brick with terra cotta trimmings. No wood is used in the construction and the roof of the dome is covered with tiles and plates while the lantern is sheathed with copper. In the lower part of the tower the details and construction of the framework are uniform except for minor features required to conform with the architectural developments of the exterior motives. At the 16th, 22d and 28th stories, there are extensions of the steel frame-work to carry projecting ornamental iron and terra cotta balconies and at the 34th story there are provisions in the center of each space for a segmental balcony of 40-ft. radius. The wall columns terminate at the 36th floor, above which the framework is continued by 12 intermediate columns terminating at the 37th floor, and four center columns continued through the lantern to the 43rd floor, and by the radial steel ribs of the segmental dome 63 ft. in diameter and 50 ft. high, which contains four stories and is surmounted by a lantern 16 ft. square at the base and 60 ft. high terminating in a domed roof 612 ft. above the curb. The highest point accessible to the public is the lantern balcony 564 ft. above the curb.



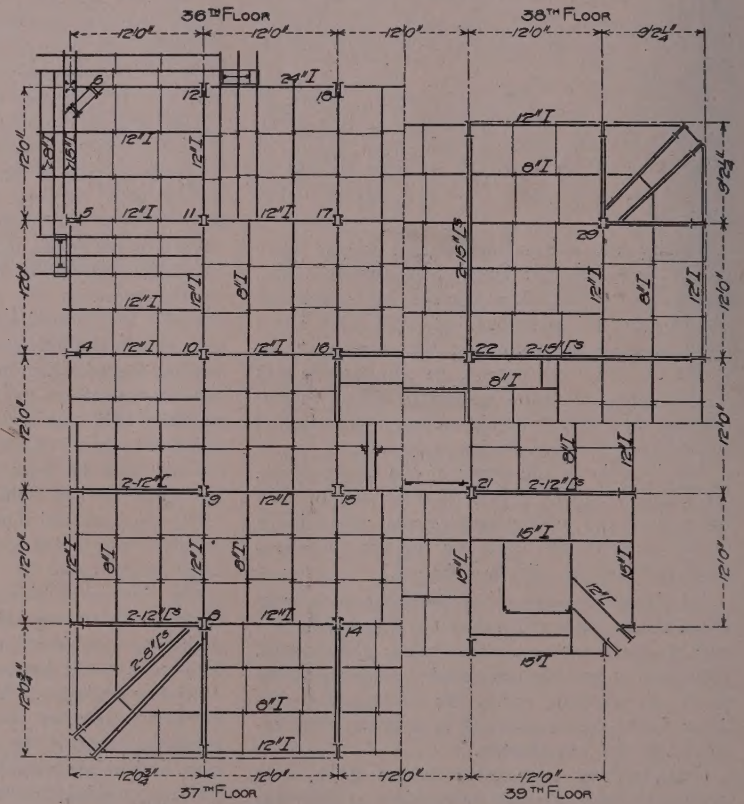
Curved Rafter and Cornice Frame.



Section of Dome and Beam Plans of Lantern Floors.



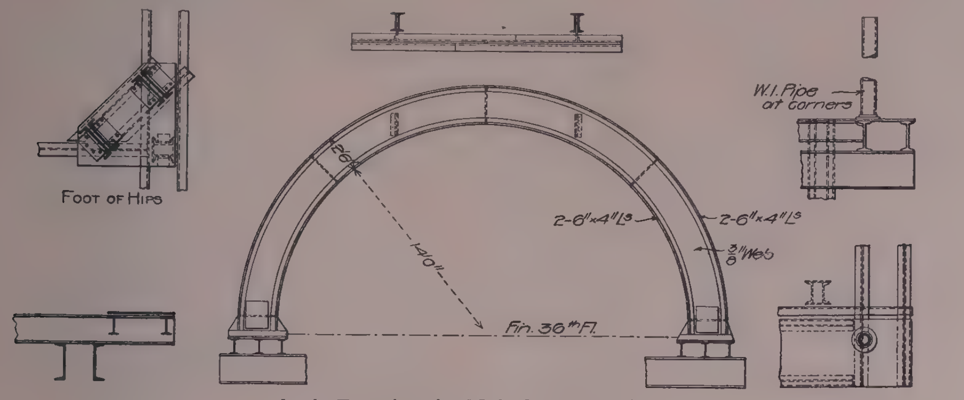
Quarter Beam Plan and Details, 33rd Floor.



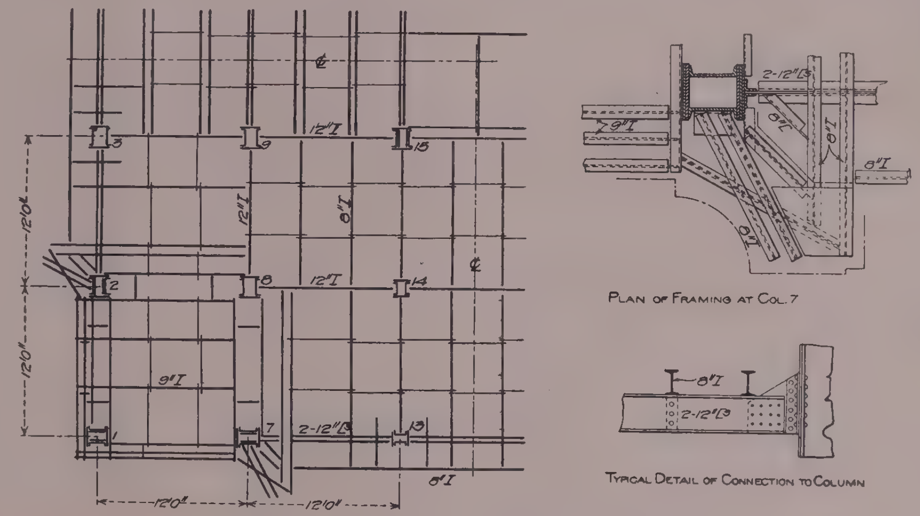
Quarter Plans of Tower Floor Framing.

The 36 columns in the framework of the tower are arranged at intersections of longitudinal and transverse lines 12 ft. apart. All of them have closed rectangular cross-sections made with channels and cover plates and their details are of the simplest type corresponding to those shown in The Engineering Record of May 18 for the columns in the lower part of the same building.

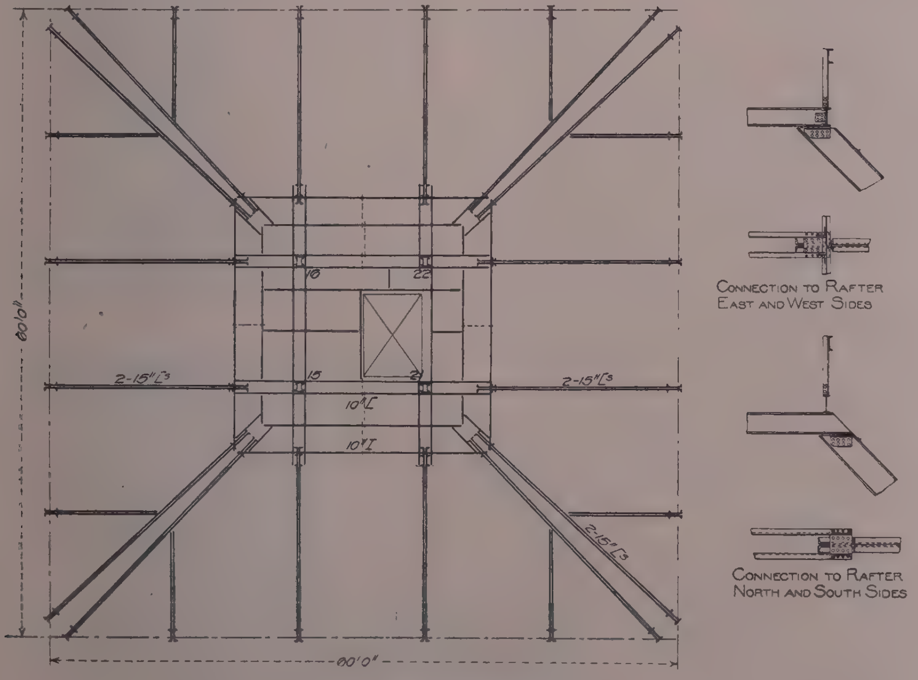
The beam plans are nearly symmetrical about both longitudinal and tranverse axes and that of the 14th floor is approximately typical of all floors up to the 33d tier. The framing is very regular and consists mostly of 8-in. and 12-in. I-beams for the interior panels and pairs of 12-in. channels for the wall girders except at the corners where special provision is necessitated for the ornamental features of the architectural construction and some rather elaborate cantilever projections are required. Each space of the tower is paneled by a group of recessed windows in the center with very heavy side moldings which are carried at each story by a set of short diagonal beams supported, as indicated by the plan at column No. 7, by direct connection to the column and by bearings across the top flange of another diagonal beam, web-connected to the extremities of cantilever girders projecting beyond the face of the wall and anchored by the interior floor loads and by connections to other girders. At the 33rd story there are segmental projections under the balconies of the 34th floor carried by the cantilever projectings of the 12-in. floor beams and by the pairs of 15-in. channel wall girders. The 34th floor beam plan is substantially like that of the 33rd floor and the 35th floor plan differs from them chiefly in the omission of the curved girders and cantilevers in all four faces.



Arch Framing in 35th Story Walls.



Quarter Beam Plan and Details, 14th Floor.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Connection to Rafter East and West Sides
Connection to Rafter North and South Sides

Dome Rafters.

At the 36th floor the 20 wall columns terminate but the arrangement of beams and girders is substantially the same as in the 35th floor except for modifications in the projecting framework at the corners, for the provisions for cantilever supports of the plate girder arches in each main face of the tower, and for slight modifications in the elevator well due to the termination of two elevators at this level. At each corner of the building sections of heavy ornamental cornice about 20 ft. long are carried 3 ft. beyond the centers of the columns by cantilever I-beams fulcrumed on the upper flanges of the wall girders and anchored at their rear end to intermediate girders. They support 12-in. and 8-in. I-beams parallel to the wall girders which are web-connected to them with their top flanges flush to receive ½-in. horizontal plates in the corners to which are flange bolted the lower ends of wrought iron pipe posts about 15½ ft. high, to reinforce the ornamental urns on the four corners. Eight groups of three 12-in. cantilever I-beams are fulcrumed on the top flanges of wall girders 24 in. deep and receive on their own top flanges riveted pedestals of full centered plate girder arch ribs 33 ft. in outside diameter. These ribs have an I-shaped cross-section made with a 30x⅜-in. web plate and four 6x4-in. flange angles and are shipped in two sections with a field riveted splice at the crown. The wall girders intersecting at the corner columns have their top flanges there covered with wide ¾-in. gusset plates rigidly connecting them and forming caps for the columns. They are also riveted to the top flanges of a pair of short diagonal 12-in. I-beams resembling horizontal knee-braces which together form a solid platform just inside the corner column and provide a footing for the two hip rafters, which like the intermediate rafters have horizontal end flanges field riveted to the beams and girders at this level. The dome rafters are nearly vertical up to the 37th floor which is about 60x60 ft. over all and is made without any irregularity or projections beyond the dome surface. Only two elevators rise beyond this level and the beam framing is regular and very simple consisting of 8-in. 18-lb. I-beams 4 ft. apart supported by 12-in. beams and channels 12 ft. apart in the interior panels, and in the exterior panels by girders consisting of pairs of 12-in. channels, back to back, corresponding to the dome ribs by which they are carried at the outer ends. In the corner panels there are pairs of similar girders connected to the hip ribs. The dimensions of the 38th floor are reduced to about 52x52 ft. and the beam framing varies to correspond with the smaller area and with the absence of the intermediate interior columns which necessitates the use of girders about 21 ft. long composed of pairs of 15-in. channels, back to back, supported at their outer ends by the dome ribs and at their inner ends by the four vertical center columns. At the 39th floor the tower is only about 40 ft. square and the diagonal girders at each corner extend from the ribs to the center columns. At the 40th floor the main dome terminates in a platform about 24 ft. square which is supported by longitudinal and transverse girders riveted across the faces of the four vertical center columns, 12 ft. apart on centers. Their cantilever extensions carry two lines of 10-in. I-beams. The outer lines of I-beams form a rectangle which receives the stress from the top of the dome ribs web-connected to their lower flanges. The tops of the intermediate dome ribs are similarly connected to the extremities of the cantilever girders which are directly fastened to the faces of the columns.

The four interior columns extend, with reduced cross sections, to a height of 34 ft. above the 40th floor to form the frame work of the lantern and terminate at a point about 2 ft. above the 43d floor level. They are stiffened at the top and at the 41st floor by solid web plate knee-braces. At the 43d floor the upper ends of the columns are connected by one 12-in. I-beam and two 12-in. channels riveted across their faces to form the simple members of a rectangle 12 ft. square. Three 8-in. I-beams about 17 ft. long are supported on the top flanges of these girders in opposite faces of the lantern and cantilever beyond them to carry the balcony floors on two sides of the lantern, on the opposite faces of the lantern corresponding projections are carried by short cantilever I-beams with their inner ends anchored to the 17-ft. I-beams. Above the 43d floor a shaft about 10 ft. in diameter rises about 20 ft. to the 45th floor and has in its frame work 8 vertical posts each made with a pair of 4x4-in. angles. These verticals have curved exterior knee braces at the base which serve as rafters carrying the horizontal purlins in the concave roof. At their upper ends they have straight knee braces each composed of a pair of 3x3-in. angles extending to the center of the channel at the 8-in. channel drum at the 45th floor. Above the 45th floor there is a dome about 7½ ft. in diameter and 9 ft. in height having 8 ribs with T-shape cross sections made with pairs of 4x4-in. angles riveted together back to back. They are braced together with horizontal T-bar purlins and unite at the crown in a drum 10½ in. in internal diameter which is made with two semi-circular pieces of a bent 8-in. channel.

The ribs of the main dome are made with pairs of 15-in. 55-lb. channels curved to a radius of 68 ft. 8 in. for the outer flange and riveted together back to back with ½-in. connection plates fixed between their webs to receive the floor beams and girders. There are four pairs of stiff ribs and eight intermediate main ribs, all of them extending from the 36th to the 40th floor besides four pairs of jack ribs extending from the 36th to the 38th floor and secured at their upper end to the stiff ribs. Three arched windows 4½ ft. wide and 8 ft. high in each face of the tower at the 37th story have a dormer like construction with a 3x3-in. angle vertical frame braced to the arch ribs by single 8-in. channels in vertical radial planes and are connected top and bottom to the floor girders. Circular dormer windows 6 ft. in diameter in the upper part of the dome have frames made with 3x3-in. angles in vertical planes which are braced to the dome framework with 3x3-in. horizontal purlin T-bars. Horizontal 3x3-in. T-bar purlins about 3 ft. apart are riveted to the outer flanges of the dome ribs to receive the sheathing.

Mr. Ernest Flagg is the architect of the building; the structural work was designed by the engineering staff of his office; Mr. O. F. Semsch, chief engineer. Messrs. Boller & Hodge are the consulting engineers. Milliken Bros. are the general contractors for the structural steel work.

A WELL BORING APPARATUS of unusual construction is now attracting some attention in Germany. It consists of a shell of the diameter of the well to be bored, which is made to rise and fall by means of a pair of hydraulic cylinders, with some special devices, attached to the end of a hollow rod suspended in the well. When a hydraulic pressure of about 140 lb. per square inch is transmitted down the hollow rod, the shell is made to rise and fall at the rate of about 50 or 60 complete strokes per minute. The mechanism also turns the shell about 45° at each stroke, and as its bottom has a cutting edge with a boring blade across it, the rate of sinking is stated to be quite rapid even in comparatively hard material. The mechanism and the cycle of operation appears to be quite complicated, but the reports of the operation of the apparatus are decidedly favorable. Two men are required to run it.

The Pollution of New York Harbor.

The Statue of Liberty stands at the center of a circle of 18 miles radius which bounds the limits of New York City and extends over 45 cities and towns in New Jersey. This circle covers about 1,000 square miles, of which three-quarters is land and one-quarter water. The pollution of this water by sewage is a subject rapidly becoming one of much importance, and an address concerning it, made recently by Mr. George C. Whipple, before the New York County Homeopathic Medical Association, contains many interesting statements.

Within the circle mentioned dwells a present population of about 4.5 millions in New York and one million in New Jersey. The sewage of this district amounts to 500,000,000 to 600,000,000 gal. daily, he states, while to this must be added large volumes of street wash at times of rain. Through the district there flows one large river, the Hudson, and several smaller ones, the Passaic, Hackensack, Rahway and Elizabeth in New Jersey, and the Bronx River in New York. The Harlem and East Rivers are tidal channels rather than true rivers. New York Harbor, or speaking more exactly, the "Upper Bay," stands at the center of the circle and from its appearance on the map would appear to act as a receiving basin for these various streams. This picture of a receiving basin or great cess-pool for the sewage is not wholly true, for the Hudson River channel preserves its identity and passes as a deep cut through the Upper Bay, the Narrows and well into the Lower Bay. The Kill von Kull is a tributary to this submerged river, while that part of the Upper Bay west of the channel is where the old Hudson River overflowed its banks when the region sank. The water over the Jersey Flats is only 5 or 10 ft. deep at low tide, and there are places where the depth is less than 2 ft. It is not impossible that another century may see these flats covered with buildings.

For the most part sewers of short length discharge the sewage at the nearest point at the shore, though there are several trunk sewers which convey the sewage of large districts to distant points. In all there are upwards of 350 sewer outlets which discharge into the waters which wash the shores of the district, exclusive of those which discharge into the New Jersey streams. Practically all of the sewage of five million people, therefore, passes into the harbor of New York, except that which settles in Newark Bay or the other streams and tidal channels.

The New York Metropolitan district is adding from 30 to 35 per cent. to its population every ten years. If this rate is kept up in another generation the population within 18 miles of Liberty Island will be nearly 10,000,000, and the amount of sewage entering the Harbor will be 1,000,000,000 gal. a day, enough to cover the Upper Bay to a depth of nearly 3 in., if it were all concentrated there, which, of course, it will not be.

That local nuisances from the disposal of sewage in the harbor exist to-day cannot be questioned, nor that they ought to be abated at the earliest possible moment. That there is a limit to the amount of sewage, which the harbor can receive must also be admitted, and before that limit is reached steps ought to be taken to avoid the general nuisance which must follow. The point at issue is as to when this limit is likely to be reached and where and in what way trouble is first likely to manifest itself. The capacity of the harbor of New York to receive sewage without giving rise to a general nuisance cannot be fairly determined at this time, in Mr. Whipple's opinion, for the facts upon which the answer depends are not known.

The disposal of sewage by dilution is generally recognized by sanitary science as a legitimate, economical and generally satisfactory method, provided the proportion of the sewage to the water into which it is discharged is not too great, provided the mixture of the sewage with the water is prompt and thorough, and provided problems of water supply or shell fish are not involved. Mr. Whipple considers it the natural method for New York situated by the sea and provided with the great tidal estuaries which here exist, and whatever may happen in the future it seems absolutely certain that this method of disposal will be used for many years to come.

From the natural advantages of Manhattan with respect to the shore line the location of main sewers has been a simple problem, but in the other boroughs there are large areas where the problem is not so simple. These areas are developing with great rapidity, demanding the constant extension of sewers. To a considerable extent this work is going on without carefully considered plans, and unless this is rectified in the near future disaster or great expense to the city will inevitably result, in Mr. Whipple's opinion.

The Borough of Queens, for instance, is now made up of separate communities having their independent sewer systems. It will not be many years before these communities grow together, and there will then be demanded trunk sewers of large size. Such trunk sewers need not all be built at once, but the general plans should be so laid out that the extensions as they are needed can be made to fit them, so that in the future it will not be necessary to design the main trunks to fit the little feeders. These main trunks should also be designed with reference to the best method of disposal by dilution and with due consideration of the need of purification in the future.

The three phases to sewage disposal in New York, as seen by Mr. Whipple, are, first, the location of trunk sewers; second, proper dilution at the outfalls to prevent local nuisances; and, third, the capacity of the harbor to receive the sewage of the future metropolitan district.

The amount of sewage matter which enters the harbor can be estimated approximately. Making a fairly liberal allowance for manufacturing wastes and street wash, and taking into account matters in solution and suspension, the total quantity is stated by Mr. Whipple at upwards of 2,000 tons per day, of which about 800 tons is organic matter subject to decomposition. There is probably at least 700 tons of matter in suspension, 40 per cent. of which is organic.

If the harbor were a body of standing water the conditions would have become intolerable years ago, but it is very far from being standing. The average daily flow of all streams entering above the Narrows is about 16 billion gallons per day, the minimum flow, 2.5 billion gallons, and the maximum flow perhaps 150 billion. There must also be considered the tidal flow, which is the real controlling factor and has been estimated as about 200 billion gallons per day. Not all of the day's flow of the Hudson River leaves the harbor in a day and not all of the sea water which enters the harbor through the Narrows is new water which has not been in the harbor before. Moreover, all of this vast tidal flow is not available for the dilution of the sewage. The sewers discharge at points near the shore, but the great volumes of water pass through the central channels. Practically speaking, it is only the water near the shores which is utilized for dilution under present conditions.

The conditions which affect dilution are quite dissimilar along the different shores. The East River receives more sewage in proportion to its width and volume and to its tidal flow than the North River, and the analyses indicate a higher degree of pollution. It is not possible to treat the subject of dilution in a general way—it must be studied locally at each point on the shore and in the main channels.

The harbor water is a mixture of fresh water and sea water, but the proportion is not constant. In the spring when the stream flows are large the water in the Upper Bay may be more than half fresh water, while during dry periods it may be three-quarters sea water. The proportion is different for the flood and ebb tides, and it is also affected by the winds.

In considering the present-day condition of the harbor the subject must be viewed from two very different standpoints, namely from that of public health and from that of public aesthetics. The two are not necessarily related to each other. Sewage may be diluted in water to a degree that would surprise even a homeopathist and yet be potentially dangerous to a person drinking it; on the other hand a person might sail in a boat over a sea of sewage, or work in sewers as thousands of laborers do, without ill effects.

Two sources of danger to public health from the pollution of the waters around New York, are contracting disease by bathing in sewage-contaminated water, and by eating shell-fish which have grown or been kept in water infected with disease germs. Bacterial analyses of waters around New York show that nowhere above the Narrows is there freedom from sewage contamination. The water over a large part of the region where oysters and clams are gathered has been shown to be contaminated, and the oysters themselves have been shown to be contaminated. Public bath-houses are located along the water front at numerous points in the North and East Rivers, and at some of these places the conditions are bound to be unsanitary. The location of a public bath house should be made with the greatest care and with special reference to the avoidance of the sewer outfalls.

Mr. Whipple believes that the sale of local oysters should be severely restricted and conducted only under certification by the proper authorities. He considers it wiser to reduce the danger by restricted sale than to indulge in the wholesale contamination of the local oyster industry.

The nuisances resulting from the too great accumulation of sewage at certain points along the shore and in some of the inlets may be classified under the heads of miscellaneous litter, discoloration of the water, odors, sleek on the surfaces, and deposits of offensive sediment on the shores.

Along the shores of the East River from the Battery to Blackwell's Island the litter which is seen floating in the water is the most conspicuous nuisance. Much of it is undoubtedly thrown overboard from boats and from the wharves. A part is garbage from the sewers. Statistics from other large cities show that every million gallons of sewage contains about 0.25 cu. yd. of matter that can be screened out on a half-inch screen. For a city like New York this would amount to about 150 cu. yd. per day—almost enough to cover an acre to a depth of 2 in. This matter scattered along the shores and collecting in eddies is enough to become very conspicuous.

Discoloration of the water is most conspicuous when the sewage is discharged into some slip or inlet. The Gowanus Canal, with its black, fetid, bubbling liquid is one of the most glaring instances of intensified pollution. Newtown Creek is another glaring case of intense pollution by manufacturing wastes. It is one of New York's sore spots, upon which it will be necessary to spend large sums of money in the near future. The Harlem River is also in danger of an overdose of sewage if the Bronx continues to grow at its present rate.

There are two well marked groups of odors caused by pollution, that of decomposing sewage, and that of manufacturing wastes, especially oil wastes. These are all local, but in many places they are very bad. Wastes from the gas works produce odors many times more noticeable than sewage, and these are mistaken for sewage by many people.

The oil and gas wastes also impart an offensive appearance to the harbor water near the works by causing an oily sleek on the surface, suggestive of pollution. Sewage from some of the large outfalls does the same.

Another noticeable nuisance in the harbor is the deposit of sewage sludge along the shores. The piles and the wharves become coated with it, vessels become coated with it, and the ice in the winter is conspicuously fouled. It forms deposits, sometimes in large amounts, on the shelving beaches which underlie many of the wharves, and on the debris which accumulates there. This is especially important where the sewers discharge at the bulkhead line instead of at the pier heads. There is a curious negative side to this nuisance. Wooden piles exposed to tidal action are destroyed in most harbors on account of the action of the teredo and other organisms, but in New York the water around the docks is so polluted that they cannot live: consequently it is found that the piles are preserved.

Many of these nuisances could be remedied, Mr. Whipple states, by an extension of the sewer outlets to the pier heads, by having them submerged at low water, and by providing some more or less elaborate device for getting the sewage quickly and thoroughly mixed with the water of the main currents. In the case of the larger sewers, screening would reduce the amount of litter and lessen the shore deposits of filth. It might even be possible to combine some of the smaller outlets, for the purpose of economical screening. These suggestions are by no means new; they were made to the Sewer Department by Mr. Rudolph Hering more than twenty years ago.

One other effect of the harbor pollution remains to be considered, namely, the problem of silt. A mass of suspended matter equal to nearly 1,000 tons is discharged from the sewers each day into the waters around New York. The Hudson River frequently contains more or less silt and clay. In the spring the turbid brownish-yellow color of the North River is conspicuous, especially at ebb tide. From the best available data, it has been calculated that the average amount of clay and silt brought down by the Hudson is about 10,000 tons a day. The suspended matter of the city's sewage therefore amounts to about 10 per cent. of the total sediment which is now accumulating in the harbor. Where the bulk of this sediment is deposited no one fully understands. The two most conspicuous regions where the cross-section of the total stream is expanded are, first, the Jersey flats, and, second, the lower bay at or behind the bar. In all probability these are the principal regions of deposit. Probably a third at least of the suspended matter is carried seaward in a finely divided or colloidal condition.

The effect of the continuous deposit of a mixture of 10 per cent. sewage sludge with 90 per cent. of river silt, is not likely to become serious from the sanitary standpoint, or even to give rise to any nuisance other than that of silting the channels and obstructing navigation, Mr. Whipple believes. There may be spots where the percentage of sewage sludge may be great enough to cause a local nuisance, but that the harbor is going to suffer a general nuisance from this cause he does not believe.

A Time-Penalty Decision by the U. S. Supreme Court.

The recent decision of the U. S. Supreme Court in the case of the Bethlehem Steel Co. is of interest to a large number of contractors who have contracts with the United States containing time penalties. The contract was made for the delivery of gun carriages to the War Department and a provision was contained in it that for each day of delay for delivery of each carriage beyond the time specified in the contract $35 should be deducted. The delivery was delayed for an aggregate of 1,096 days for the various gun-carriages, and the War Department decided that the contractor was responsible for 600 days of this delay. Twenty-one thousand dollars was deducted in the payment made to the company, which receipted under protest for the balance. The United States suffered no damage by reason of the delay as the fortifications in which they were to be placed had not been completed.

It appears that in all the original negotiations between the government and the contractor a higher price was to be paid for prompt delivery. The amount of deduction fixed in the contract was fixed by taking an average difference of prices offered for deliveries at a quicker or slower rate.

The Court of Claims held that the deduction was a penalty, and that the well-known rule of law applied that no deduction could be had under a penalty clause unless actual damage was shown. There having been no actual damage, judgment was given by that court for the entire amount withheld.

The Supreme Court reversed the Court of Claims and ordered the dismissal of the claimant's petition. They took into consideration the prior negotiations between the United States and Bethlehem Steel Co., and showed that the company was to receive a higher price under its bid for quick delivery than for delayed delivery and that the deduction provided in the contract was nothing more than carrying out this theory of the performance of the contract obligations. They said that the parties clearly intended that a less amount should be paid if there was delay than if the gun carriages were delivered promptly as contracted for. They found that there was no extraordinary disproportion between the amount fixed in the contract and the actual damages which might result from the failure to deliver on time. They therefore concluded that the parties intended the $35 a day to be liquidated damages and that the intention of the parties should be carried out.

While the circumstances of this case are peculiar and probably will not be duplicated in many contracts, the expressions of the opinion, on the whole, are unfavorable to contractors. Similar provisions have been repeatedly held by the courts and by the Treasury Department to be subject to proof of the actual damages suffered by the government. Accordingly the penalties fixed in such contracts have been reduced to the amount of damages actually shown. This particular case does not go so far as to upset this principle, but it will serve to warn contractors of the necessity of great care in relation to the form of their contracts as to damages for delay.

THE FORESTRY WORK of the Pennsylvania R. R. has been placed under the charge of Mr. E. A. Sterling, formerly with the U. S. Bureau of Forestry. The company is developing large plantations at Mount Union and at Altoona, while at Hollidaysburg it has established a nursery. It is planting catalpa, locust, Scotch pine, red oak, chestnut and other quick-growth species which are not considered first-class for ties without treatment.

Experiments on the Preliminary Treatment of Water at Washington.

A series of experiments on the preliminary treatment of water is now being carried on by the engineers of the filtration plant of Washington, D. C. This plant, which is of the slow-sand type, has been in operation since Oct., 1905, about 19 months, and has effected a marked improvement in the water supply of the city. The supply is now giving general satisfaction, except as to turbidity, and there have not been any complaints from the public or the medical profession. The effluent from the filters has a low bacterial content, the average in only four months, being over 50, while in twelve other months it has been less than 30. The desirability of having a perfect supply, if possible, from the standpoint of turbidity, and the fear that the beds may be eventually injured by the suspended matter which is permeating their entire depth, as is evident from the turbidity of the effluent, has led the authorities to make the present investigations.

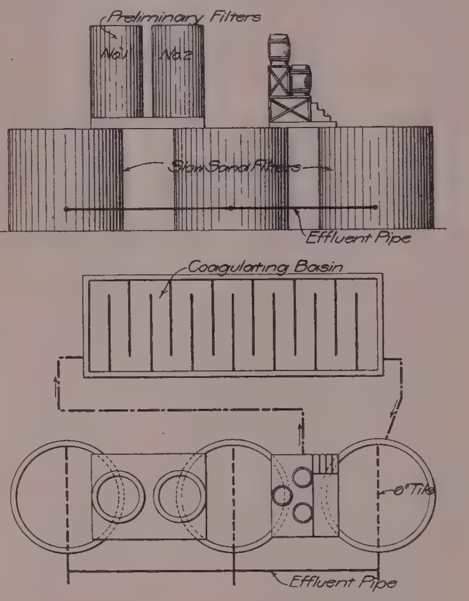
It will be remembered that when the construction of these filters was recommended the project included the occasional coagulation of the raw water. Messrs. Hering, Fuller and Hazen, in their report to Congress, stated clearly that sand filtration without such occasional coagulation would not adequately clarify the Potomac water. The plant was authorized without the provision for the occasional use of coagulation because of opposition, especially by the physicians, to the use of chemical treatment; but it is to be noted that the doctors have since officially withdrawn their objection. Various proposals have also been made that preliminary filtration should be substituted for chemical treatment.

The water now supplied in Washington after passing through the sand filters is turbid to an extent which is occasionally objectionable, and it is important that the purification process, as originally proposed, should be completed. In the absence of authority for the regular use of coagulation, these experiments were undertaken, first, as a practical demonstration and test of the recommended process; and, second, to see what results could be accomplished by preliminary filtration as an alternative to the recommended arrangement.

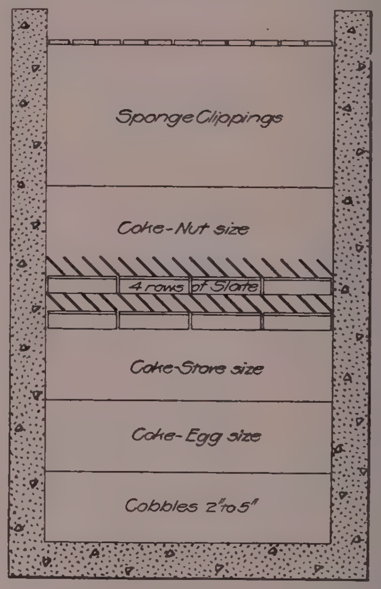
The raw water is taken from the Potomac River at Great Falls, 14 miles above the city, and is carried to the Dalecarlia Reservoir 9 miles below, and then successively to the Georgetown and Washington City Reservoirs, located at distances of 3 and 7 miles, respectively, from the first basin. The capacities of the first two reservoirs are approximately 150,000,000 gal. each, and of the last, which is situated at the filtration plant, 300,000,000 gal. The daily consumption is 70,000,000 gal. The effective period of sedimentation is about 4 days and the water consequently is well settled before reaching the filters, with the result that the sand and silt have all been removed. Regarding the condition of the influent to the filters and the matter in suspension Messrs Allen Hazen and E. D. Hardy have stated in a paper before the American Society of Civil Engineers that "the residual turbidity which reaches the filters is entirely of clay, and most of it is in an extremely fine state of division. The water often or usually does not contain particles of a size to form at the surface of the sand the sediment layer usually obtained in the operation of sand filters. The clay particles penetrate the sand to a considerable depth and gradually fill up the pores in the upper part of the sand layer to a depth of 2 or 3 inches. Others go deeper and are deposited in the lower part of the sand layer, while still others go entirely through the filter and appear in the effluent."

The investigations are being made with three different methods of preliminary treatment, the first consisting of an ordinary sand filter operated at a high rate, the second a Maignen pre-filter, and the third coagulation. A well-equipped experimental plant has been erected at the Dalecarlia Reservoir, and the arrangement is shown diagrammatically in the accompanying sketch.

The plant contains three distinct and complete filtration outfits, each one composed of devices for the preliminary treatment, a slow-sand filter, and the necessary piping and apparatus for securing the measurements required. The first set, termed No. 1 in the drawing and table, consists of a preliminary filter 4 ft. in diameter containing a 3-ft. layer of sand over a layer of graded crushed stone which surrounds the effluent pipe. The latter is of 3-in. tile laid with open joints. The effluent from this filter discharges into a slow-sand filter. Set No. 2 has a Maignen pre-filter 4 ft. in diameter, the water passing through it in an upward direction, and discharging into the second slow-sand filter. The arrangement of the coke and sponge clippings is shown in the accompanying diagram. Imbedded in the uppermost layer of coke are four rows of plates of slate placed as a grid, and inclined about 30 deg. to the horizontal, in order to deflect the water from a straight vertical path. Set No. 3 consists of a coagulant mixing tank and distributing device, and a coagulating basin discharging into a slow-sand filter. The coagulating basin is situated outside the building which houses the filters, and has a capacity of about 13,000 gal.



Arrangement of Experimental Plant.



Section of Maignen Pre-Filter.

The three slow-sand filters are identical in construction, and the sand and stone were brought from the filtration plant so that the conditions would be the same, except for the character of the influent, as at the present filters. The underdrain is of 3-in. tile pipe laid with open joints and covered with a 1-ft. layer of gravel and graded broken stone, the largest size stone being 2 in. Above this layer is the sand bed 3½ ft. thick.

The loss of head in all the filters is read by suitable gauges, and in the slow-sand filters is taken at three different points vertically distributed through the sand bed in addition to the total loss of head. Nash meters on the effluent pipes of all three slow-sand filters measure the quantity of water filtered. The effluent pipe of any of the latter filters can be made to discharge into the effluent of either of the other two so that after a filter has been emptied for cleaning or other purposes, it can be refilled from the bottom with filtered water. The coagulant mixing tank and distributing device are situated to discharge directly into the raw water as it passes to the coagulating basin.

The filters are built of reinforced concrete with 6-in. walls, and the coagulating basin of plain concrete, the sides having a gravity section. The preliminary filters are carried on a 1-ft. reinforced concrete slab which rests on the walls of the slow-sand filters. The coagulant devices are similarly supported, but the slab is 6 in. thick.

The water used in the investigation is taken from the conduit immediately below the gatehouse which controls the flow from the Dalecarlia Reservoir, so that the water has been improved over its character at the Great Falls intake by sedimentation in the first reservoir. Hourly observations are made of the loss of head and of the quantity of water filtered, and the turbidity readings every 4 hours. These readings are taken day and night. One sample of water for examination for bacteria is taken each day at the various points, as shown in the table, and these samples are at once carried by special messenger to the laboratory of the filtration plant in Washington.

The experimental plant was put into operation on Feb. 8 of the present year, but the results of the operation for that month are rather irregular, and not characteristic, because of shut-downs in order to make various changes, and the interruptions incident to starting a new plant. For that reason the results for the month of February are not given here. The rate of filtration in the preliminary filters corresponding with the data here given was 4,000,000 gal. per acre per day, except during the month of April for the filter connected with the coagulating basin in which the rate was 3,000,000. The corresponding loss of head for the filter of set No. 1 was between 0.11 and 0.16 ft.; for No. 2 it was 0.16 ft. on March 1, increasing gradually to 0.41 ft. on Apr. 30; and for No. 3, 0.72 ft. on March 1, increasing to 4.18 ft. on March 24, then dropping to 0.22 ft. after scraping and rising to 2.83 ft. on April 30. The rate of the preliminary filters is 50,000,000 gal. per acre per day. The loss of head in preliminary filter No. 1 increases very rapidly from a minimum of about 0.75 ft. to about 6 or 7 ft., attaining the maximum in from 3 to 8 days. It is then shut down and cleaned. The loss of head in the preliminary filter No. 2 was 0.04 ft. on March 1 and increased gradually to 0.49 ft. on April 30. The slow-sand filter of set No. 3 was cleaned on March 25 and 26 after a run of 37 days, by removing 1.03-in. of sand. During that period the quantity per acre which had passed through the filter was 141.72 million gallons.

The coagulant used is sulphate of alumina containing 17 per cent. available alumina, and is expressed in the table in pounds per million gallons.

RESULTS OF EXPERIMENTS WITH DIFFERENT WATER PURIFICATION PROCESSES AT WASHINGTON.

Date.	Turbidity							Coag. used in No. 3.	Bacteria Per C.C						
	Raw.	Effl. Pre. Process.			Effl. Sand. Fil.				Raw.	Effl. Pre. Process.			Effl. Sand. Fil.		
		No. 1.	No. 2.	No. 3.	No. 1.	No. 2.	No. 3.			No. 1.	No. 2.	No. 3.	No. 1.	No. 2.	No. 3.
Mar. 1	15	5	8	—	3	3	3	0	650	450	550	—	140	200	300
2	15	5	7	—	3	3	3	0	1,000	650	800	—	200	300	270
3	31	8	11	—	3	3	3	—	Sun.	—	—	—	—	—	—
4	35	10	15	—	5	6	3	208	1,200	—	1,500	—	—	360	140
5	135	39	52	—	8	10	4	278	13,000	3,700	850	—	600	—	190
6	135	39	54	29	8	12	2	290	18,000	4,500	8,000	2,100	—	—	160
7	102	34	46	15	6	8	1	214	24,000	5,000	6,500	3,500	2,000	1,800	160
8	100	25	40	15	4	6	1	198	22,000	5,000	6,000	1,800	1,400	1,600	130
9	90	25	40	15	4	5	1	196	24,000	4,000	6,000	3,500	650	800	130
10	82	22	39	16	5	6	1	181	Sun.	—	—	—	—	—	—
11	68	19	32	18	6	7	1	178	18,000	2,100	4,300	6,000	350	240	120
12	46	19	25	18	4	5	1	155	11,000	6,000	4,600	9,000	310	210	140
13	40	19	20	15	4	5	1	142(½ da.)	9,000	4,900	1,500	5.000	300	200	120
14	39	17	20	16	4	4	1	0	5,500	1,300	1,200	3,600	130	90	90
15	35	15	18	20	4	4	1	0	6,500	1,500	1,100	3,800	60	150	85
16	60	20	24	29	4	4	1	180(½ da.)	5,000	1,200	800	3,500	100	160	100
17	135	35	45	25	4	5	1	218	Sun.	—	—	—	—	—	—
18	170	49	59	25	7	9	1	250	9,000	1,200	1,700	1,900	95	100	85
19	125	37	51	21	6	8	1	225	7,000	600	1,000	700	100	120	65
20	102	30	40	20	5	6	1	187	4,800	300	700	1,500	75	75	60
21	125	32	42	20	4	5	1	197	8,500	1,000	1,100	1,500	85	90	70
22	190	65	82	25	4	5	1	225	7,500	1,100	1,100	1,100	45	55	35
23	180	65	75	26	6	6	1	240	7,500	600	1,300	470	55	90	55
24	140	52	68	19	7	7	1	217	Sun.	—	—	—	—	—	—
25	88	30	40	—	5	5	—	—	4,400	500	900	—	85	75	—
26	62	22	32	—	4	4	—	—	3,600	300	750	—	65	90	—
27	47	18	25	8	4	4	1	154	2,200	160	400	480	60	60	60
28	35	10	16	—	3	3	0	143	1,300	100	350	250	55	55	80
29	26	8	12	—	3	3	—	0	700	80	180	240	29	20	65
30	25	6	7	—	3	3	—	0	310	70	220	—	35	39	—
31	21	5	6	15	2	2	1	0	Sun.	—	—	—	—	—	—
Apr. 1	20	5	6	15	2	2	1	0	600	25	110	1,000	30	38	43
2	24	5	6	17	2	2	1	0	270	28	110	—	32	29	35
3	24	5	6	17	2	2	1	0	460	26	85	—	43	31	41
4	20	5	6	15	2	2	1	0	280	20	60	550	26	22	27
5	20	4	5	13	2	2	1	0	450	37	70	1,000	41	40	60
6	20	4	—	12	2	—	1	0	320	6	—	50	34	—	35
7	20	4	—	12	2	—	1	0	Sun.	—	—	—	—	—	—
8	18	3	4	12	2	3	1	0	330	10	—	650	20	—	22
9	18	3	4	12	2	2	1	0	140	9	60	750	35	32	21
10	30	2	4	15	1	1	0	0	750	43	120	5,000	29	28	29
11	66	4	7	16	1	2	0	158	4,000	900	—	550	26	32	25
12	72	11	20	13	2	3	0	165	14,000	1,700	2,900	2,200	41	85	17
13	80	21	30	19	2	3	0	163	13,000	1,300	2,500	3,900	70	95	25
14	77	25	35	18	3	4	1	167	Sun.	—	—	—	—	—	—
15	62	21	31	18	3	4	1	156	7,000	380	1,100	2,200	55	60	19
16	47	20	27	17	3	4	1	150	3,600	160	650	900	33	31	22
17	39	15	21	19	2	3	0	0	1,600	70	160	1,100	39	38	12
18	30	10	13	20	2	2	1	0	1,810	130	210	1,870	34	42	14
19	25	7	9	18	2	2	1	0	790	50	190	910	32	34	14
20	20	5	6	15	2	2	1	0	540	24	87	480	28	23	15
21	20	3	4	15	2	2	1	0	Sun.	—	—	—	—	—	—
22	18	2	3	12	1	1	0	0	235	15	55	420	28	22	21
23	15	2	3	10	1	1	0	0	170	14	45	420	16	16	8
24	19	1	2	10	1	1	0	0	150	32	14	250	14	14	17
25	34	1	3	12	1	1	0	0	700	20	12	260	18	23	19
26	46	2	4	12	1	1	0	0	1,200	16	80	320	16	16	80
27	52	3	4	—	1	1	0	0	1,700	25	160	1,500	17	23	70
28	45	4	5	—	1	1	1	0	Sun.	—	—	—	—	—	—
29	44	5	6	33	1	1	1	0	600	16	60	1,400	17	10	19
30	39	6	7	29	1	1	1	0	550	27	55	1,200	12	15	14

The general rule followed at first was to use the coagulant when the turbidity of the raw water was 40 or over, but this minimum limit was later raised to 60, and still later to 80.

A study of the data thus far obtained presents some interesting points. The rise and fall of turbidity of the effluent from the preliminary filters follows closely the variations in the turbidity of the raw water, whereas the turbidity of the effluent from the coagulating basin is less affected by the changes in the raw water, though increasing somewhat with the turbidity of the latter. During times of high turbidity of the influent, the turbidity of the effluents from the preliminary filters is much higher than that from the coagulating basin, while in times of raw water turbidity as low as 25 or 30, the conditions of the effluents are reversed.

The turbidity of the effluents of the slow-sand filters for No. 1 and 2, though less affected than the effluents from the preliminary filters by the changes in the raw water still shows the same tendency to rise and fall with those changes; whereas the turbidity of the effluent from slow-sand filter No. 3 which is fed from the coagulating basin is constant. This latter turbidity has not gone above one since the first application of the coagulant, despite the fact that for considerable lengths of time no coagulant has been used.

In the case of the bacterial content, the values in the effluents of the preliminary filters follow the rise and fall in the content of the raw water, while the changes in the content of the effluent of the coagulating basin appears to have little connection with the changes in the raw water. The number of bacteria in the final effluents is greater for the first two processes than for the third.

The effect of the coagulant on slow-sand filter No. 3 into which the coagulating basin discharges is quite marked. All three slow-sand filters are the same in construction in every particular, yet it will be noted that between April 1 and 10, and again between April 18 and 30, though the turbidity and bacterial content of the water applied to slow-sand filter No. 3 were much greater than those of the water applied to the other slow-sand filters, the turbidity and bacterial content of the effluent of No. 3 were less (except for a few days near the end of April) than those of the effluents from the other filters.

MONTHLY AVERAGES OF REGULAR AND EXPERIMENTAL PURIFICATION.

	Turbidity		Bacteria	
	March.	April.	March.	April.
Main filters	4	2	64	21
No. 1 Process	5	2	290	30
No. 2 "	5	2	290	33
No. 3 "	1	1	118	28
Raw water	77	33	8,295	2,125

The experiments are being made by Mr. E. D. Hardy, superintendent, and Mr. F. F. Longley, assistant superintendent and chemist of the Washington filtration plant, under the general supervision of Capt. Spencer Cosby, U. S. A., Corps of Engineers.

THE VALUE OF THE STORAGE BATTERY in central power station service was recently exemplified in a breakdown of generating apparatus at Waterside Station 1 of the New York Edison Co. During the heavy evening load period, a few minutes after 9 o'clock on April 20, a 5,000-kw. turbo-generator while carrying its normal load suddenly broke down, and at the same instant a 4,000-kw. engine-driven generator burned out, while the engine of still another 4,000-kw. unit was disabled. Current was accordingly entirely cut off from the switchboard for a few minutes to rearrange the connections, but owing to heavy draughts from the storage batteries in the 23 substations distributed in different parts of the distribution system, no part of the city was deprived of supply. Throughout the greater part of the city the distribution system was unaffected, while in one small section only the voltage dropped, for a few minutes only, to about 80 volts.

The Collection and Disposal of City Wastes.

A report concerning the collection and disposal of city wastes in Rochester, N. Y., together with a description of plants and methods in use in some other places, has been prepared by Mr. Edwin A. Fisher, city engineer of Rochester, and from it the following notes have been taken. The principal wastes of Rochester are designated as street sweepings, ashes and rubbish, and garbage and dead animals. Street sweepings consists of all street refuse, such as horse droppings and debris of street paving, together with dirt brought on from intersecting unimproved streets or alleys. In 1903, about 67,000 cu. yd. of this material was collected in Rochester at a total cost of about $79,000, or $1.17 per cu. yd. The amount per 1,000 persons was about 392 cu. yd. or 267 tons. The amount of such material collected in any city depends largely upon the character of the street pavements. Mr. Rudolph Hering states that according to an inquiry made by the United States Department of Agriculture in 1898, the amount of such material collected annually in the various cities of the United States amounted to 168.9 tons per 1,000 persons. The quantity reported for London was 150 tons, and for Berlin 125 tons. In Rochester, as in many other American cities, this material is disposed of satisfactorily in filling low land.

Ashes, paper and other miscellaneous refuse, consisting mainly of wood, straw, rags, leather, glass, metal and all trade refuse, is classed in Rochester as ashes. This mixed material is generally used in filling deep ravines. Estimates made during the months of June, July, August and September, 1904, indicate that the composition of this material during the summer months is about as follows: Ashes, 25 per cent.; paper, 28 per cent.; miscellaneous refuse, 47 per cent. An examination made on a somewhat different basis in the month of January, 1905, indicates that the winter refuse is composed of about 80 per cent. ashes and cinders and 20 per cent. miscellaneous refuse. Of the 80 per cent. of ashes and cinders 5 per cent. was cinders and 75 per cent. was ashes. The average for the year by measurement is about 50 per cent. rubbish and 50 per cent. ashes.

The collection of ashes and rubbish is done by day labor. According to the annual reports of the Department of Public Works from 1900 to 1905, the quantity of material collected annually per 1,000 inhabitants has varied in that time from 584 to 642 tons, and the cost per capita has ranged from 47 to 53½ cents. The cost per cubic yard for collection and disposal has varied from 35 to 39.8 cents. Mr. Fisher estimates that a cubic yard of ashes weighs 1,600 lb. and a cubic yard of rubbish 200 lb.

The term garbage, as defined in the contract for the collection of such material in Rochester, means "all kitchen and table waste, swill, offal and market refuse, and all putrescible matter, both solid and liquid, animal and vegetable, which may result from the preparation of meats, fish, fowl and vegetables of any character, or which may be caused by the decay of food stuff, or by handling, storing or dealing in the same. The estimated weight of this material, based on several tests, is about 1,169 lb. per cubic yard. This is a little lower than the average of 1,405 lb. per cubic yard given by Dr. Charles B. Chapin for sixteen American cities.

The ordinance of Rochester provides that the garbage receptacles shall hold not less than 3 nor more than 10 gal., and that enough receptacles shall be provided to contain all the garbage of every building, allowing for at least 1 gal. of garbage for each individual boarding in the building. The receptacles must be used exclusively for garbage. Mr. Fisher believes that these regulations are sufficient, except that the receptacles should be of metal, and that dishwater and other liquid waste should not be put in the cans. Under the present contract garbage is collected daily in the thickly populated portion of the city, and from hotels and restaurants, and twice a week in the remaining portion of the city during the summer months, and once a week for the remainder of the year. The wagons used have tight wooden boxes holding 3.23 cu. yd. when even full. While passing through the streets the garbage is covered with canvas, and the wagons and also the garbage receptacles are disinfected when emptied. There is little complaint of odors from garbage collections when the regulations are carefully observed, but it would be better if collections were made three times per week in the portion of the city now covered by the twice-a-week collection. Steel wagons should be required both for the general collection of city garbage, and also by farmers and others taking garbage from hotels and restaurants.

Garbage may be disposed of by feeding it to animals, using it as a fertilizer, burying it in the ground, dumping it into large bodies of water, extracting the grease and other valuable products by the reduction method, and by burning it. Mr. Rudolph Hering says that of 150 American cities of over 25,000 inhabitants, 35 dispose of most of their garbage by feeding it to swine. In New England this method is very generally used. The annual cost of collection in 1901 in several New England cities where the garbage was collected by contractors who fed it to swine, according to Dr. Chapin, was as follows: Portland, 10 cents per capita; Haverhill, 7 cents; Fitchburg, 9 cents; Holyoke, 2 cents; New Haven, 5 cents. The cost of collection by city employees in six New England cities in 1901 ranged from 15 to 29 cents per capita, not taking into account the profit derived from the sale of the swine. In one of these cities, Worcester, Mass., the cost of collecting garbage in 1900 was about $17,000, and the profits $11,300. About 1,800 swine were kept, on the average.

Garbage is used as a fertilizer in a number of cities, and according to Mr. Hering it is disposed of in about fifteen large American cities by burying it in the soil. There is no very serious objection to the latter method if the garbage is comparatively fresh and is immediately covered. One practical objection, however, is the large amount of land required. In Rochester the cost of disposal when the garbage was used as a fertilizer or buried in the soil ranged from 15 cents to 22.8 cents per capita for the years 1901 to 1905 inclusive. During the same period the cost of disposal per ton ranged from $1.38 to $1.74.

Disposal by the reduction method is essentially a manufacturing and commercial enterprise, and, owing to the expensive plant required, is well adapted only to the larger cities. According to Mr. Hering this process is successfully used in about twenty of the larger cities of this country. It consists in general in extracting grease and other valuable constituents from the garbage. Naturally reduction works are more or less offensive, and great care is required to prevent a nuisance. As they are operated by private concerns for profit it is necessary for the public to enforce such care and the consequent restriction adds to the cost. The plants are generally located outside of the city, and in several instances the garbage is transported to the plant from the collecting station in the city on a railroad. Some of these plants have been in successful operation for a number of years, among which may be mentioned those at Buffalo and Detroit. By the reduction process garbage is divided into several classes of material, about as follows: Water, 70 per cent.; refuse, 7; grease, 3; tankage, 20. The grease sells at 2½ to 3 cents per pound, and the tankage at $4 to $6 per ton. Tankage may be used as a filler for fertilizers or burned as fuel.

Very few statistics of any value concerning the cost of disposal by the reduction method are available. The city of Cleveland, Ohio, during 1905 owned and operated a disposal plant of this type which, prior to 1905, was operated by the Newburg Reduction Co., under a 5-year contract, at the rate of $69,400 per year for collection and disposal. During 1905 the total cost to the city for operating the plant was $54,449.38. The cost of operating the collection department was $62,803.78. The gross earnings from the sale of the by-products during the year were $65,881.14. The appropriation for the year was $66,553.63 or $2,846.37 less than was paid the contractor, notwithstanding the fact that 25 per cent. more garbage was collected during 1905 than in 1904.

About 35 cities out of 160 in the United States of over 25,000 inhabitants, cremate their garbage, according to Mr. Hering. In Europe and England this is a favorite method of disposal and the furnaces are often used to generate steam for various purposes. There, garbage, rubbish and ashes are collected and burned together, and the work is generally done by experienced employees. English and European garbage is said to contain less moisture than American and there is enough readily combustible material collected with it to make the mixture burn easily. In England, according to Mr. T. Codington, the unconsumed coal and cinder in domestic ashes is estimated as about 35 per cent. of the ashes. In Berlin Messrs. Bohm and Grohn give the proportion of unconsumed coal as 3 per cent. In New York City the percentage of unconsumed coal in the ashes is said to range between 20 and 40 per cent., averaging about 25 per cent.

The average proportion of moisture in kitchen garbage in the larger cities of the United States is about 70 per cent. This is considerably larger than in English or German garbage. A rough approximation for New York City places the amount of such material as tin cans, berry baskets, bottles, etc., which naturally accompanies garbage, as about 7 per cent. of the whole.

In America garbage crematories generally have not been successful and many have been abandoned as nuisances or as too expensive to operate, owing to the coal or other fuel that had to be burned with the garbage. The difficulty has been due apparently to the fact that the garbage was too moist, and because it was burned alone or with coal. In a number of American cities coal is necessary even though the garbage is drained and dried before it is put in the furnace. When dry rubbish is mixed with garbage a great deal of moisture is absorbed and then slowly evaporated. Less coal is then required.

In Trenton, N. J., coal equal to 7 per cent. of the weight of a mixture of garbage and rubbish was necessary to sustain combustion. The garbage was 80 per cent. water.

Furnaces operating with natural draft are common in this country. High chimneys are required, and there is a tendency to expel unburned particles. In Europe forced draft is preferred, either steam or air, generally the latter, being forced under the grates. Much higher temperatures are thus produced. Every furnace should be arranged to prevent the escape of dust. The escape of large floating particles is prevented by screening the fumes which should have a velocity on their way to the stack of not more than 1.5 ft. per second. With properly designed furnaces success still depends largely upon a judicious selection of material and intelligent operation.

There seem to be no instances in this country, according to Mr. Fisher, where garbage, alone or mixed with ashes and rubbish, has been burned to produce steam. Furnaces for the destruction of rubbish, however, have generated steam for mechanical purposes. In New York and in Boston 1¾ lb. and 1¼ lb. of water, respectively, were evaporated per pound of rubbish. The composition of New York rubbish as given by Mr. MacDonough Craven is: Paper, 75 per cent.; rags, 15.5 per cent., and miscellaneous material, such as leather, wood, metal and glass, 9.5 per cent. The calorific value of fairly dry garbage has been given as 2,500 B. t. u., and when moderately wet as 1,000 B. t. u.

Mr. Fisher believes that the wastes of Rochester eventually will be collected by the city and disposed of by burning but, in view of the unsatisfactory results obtained in this country by this method up to the present time, he recommended that the city enter into a five-year contract under which the garbage shall be collected in steel wagons and disposed of in a satisfactory plant, land being provided in which the garbage would be buried in case the plant was temporarily out of order. He further recommended the separation of the ashes and rubbish and the construction of a suitable plant in the city for the destruction of the rubbish, this plant to be built and operated by the city or under contract for a five-year period.

An Asphalt Repair Plant.

An asphalt repair plant has been run for the last two years by the Metropolitan Street Railway Co., of Kansas City, Mo., which is required to keep up the paving between the tracks and for 18 in. on either side of the outside rails. The equipment used for this purpose consists mainly of furnaces and pans for heating the old asphalt and of tanks in which new binding material is melted. The heating pans are of ¼-in. boiler iron, 10 ft. long, 5 ft. wide and 10 in. deep in the middle. The bottom is a portion of a circle sloping down gradually from the sides. This shape permits the stirring irons to be used to best advantage. At their middle point the pans are strengthened by a cross-brace. After considerable experiment this shape of pan was found to be the best adapted for the work. Deeper pans have been abandoned because of the difficulty of stirring the material. Two of these pans are placed end to end over a brick furnace with their adjacent ends just far enough apart to permit the furnace stack to extend up between them. The old material is broken up in pieces about 5 in. square and the pans are filled level full. A fire is built in the furnace and the material allowed to heat for about two hours. In the meantime it is continually stirred with bars in such a manner that the material is thrown up from the bottom. This stirring not only prevents the asphalt from burning, but also throws gravel and other impurities to the top where they can be raked off. A few buckets of water are added from time to time during the heating process. After the material has become well heated, from 75 lb. to 200 lb. of fresh asphalt, which is kept melted in adjacent tanks, is mixed with it. From the pans the hot asphalt is loaded directly into wagons in which it is hauled to the point to be used. The two pans over each furnace hold just one wagon load, and this amount covers about 25 sq. yd. when spread 2 in. thick. Usually four double pans are operated and from sixteen to eighteen wagon loads are heated per day. The labor required at the pans is about one man per wagon load per day. Work is started very early in the morning and is discontinued at about 4 o'clock in the afternoon to permit the last material heated to be laid in the street before dark. The old material is purchased from the city at $0.75 per wagon load, equivalent to 1½ cu. yd. Old ties are used for fuel. The asphalting plant, with a capacity of 400 yd. per day, cost approximately $400. As the contract price for asphalting was never less than $1.12 per yard, and the cost under the present system is about 40 cents, it may readily be seen that the installation and operation of the plant is a very economical venture. It is estimated that the repeated asphalt will last as long as new material. Some that has been in use for two years shows every evidence of substantiating this belief. The track work and asphalt plant is under the direct supervision of E. Butts, civil engineer for the company.

Book Notes.

A table giving the cubic feet of air which will pass through air-ways of different cross-sections under pressures ranging from 0.1 to 5 in. of water has been prepared by Mr. C. H. Kuderer. The main table gives the volume per minute through 1,000 ft. of air-ways from 1 x 1 ft. up to 10 x 10 ft., while a supplementary table gives constants for reducing these figures to capacities for other lengths of air-ways. The table has been calculated from Atkinson's formula. It is sold at 25 cents by E. E. Meyer, Allegheny, Pa.

In a small book entitled "Mechanical Engineering Materials," Mr. E. C. R. Marks, has brought together a large amount of information concerning the properties and treatment of such materials. The contents begin with cast-iron and take up afterwards in turn, wrought-iron, steel, case-hardening and Harveyizing, copper and its various alloys, aluminum and bearing metals. The information seems to have been compiled with considerable care, and it is presented in a form which makes it useful to those who do not care to be bothered with the elaborate details of metallurgical research given in books of a more ambitious character. The book is essentially one for shop use, rather than for the advanced engineering students. (New York, D. Van Nostrand Co.)

The 1907 edition of the "Architect's Directory and Specification Index" follows substantially the same lines as earlier editions. It contains a complete list of the architects in the United States and Canada, so far as it could be prepared by careful search. The names are classified by states and towns, and the members of the American Institute of Architects are specially indicated. The names of officers and locations of the different architectural associations in the United States and Canada are given. There is also an index of leading dealers and manufacturers of building materials and appliances; this latter portion of the book has been materially revised lately, and is much more complete than ever before. (New York, William T. Comstock, 23 Warren St., $3.)

For a number of years Mr. H. A. Garratt, head of the engineering department of the Northern Polytechnic Institute at Holoway, lectured on the principles of mechanism from a series of notes which has recently been published under the title of "The Principles of Mechanism." The lectures were intended for pupils who had already become familiar with mechanisms and their object was to arrange the knowledge of the students into a systematic form while examining the underlying principles more closely. A large part of the merely descriptive matter usual in text-books on the subject has accordingly been omitted so as not to obscure a clear perception of the anatomy of the subject. The book contains an explanation of the kinematics of machines, and also of their dynamics, and is an unusually clear elementary presentation of the subject. (New York, Longmans, Green & Co., $1.10.)

The "Proceedings" of the Twenty-sixth Convention of the American Water Works Association, held at Boston last year, form a volume of nearly 700 pages. The papers presented at this meeting were, as a rule, more generally important and interesting than those at previous conventions. They covered a wide range of subjects, such as water purification, the pollution of water supplies by sewage, pumping machinery, the determination of the value of water works, various subjects connected with the distribution of water, the Cheesman dam, the Metropolitan water-works, and high-pressure water systems for fire protection. The papers were profusely illustrated in many cases, and the discussions they brought out were as valuable as the papers themselves. The volume should be in the office of every water-works department, and can be obtained from the secretary of the Association, Mr. J. M. Diven, 14 George St., Charleston, S. C.

Designers and managers of water-works plants will be interested in the publication by the National Fire Protection Association, 382 Ohio St., Chicago, of the specifications of essential features for hose couplings and hydrant fittings for public fire service which have been adopted by the National Board of Fire Underwriters, the American Water Works Association, the New England Water Works Association, the Pennsylvania Water Works Association, the International Association of Fire Engineers, the National Firemen's Association, the North Carolina State Firemen's Association, the Virginia State Firemen's Association, the Minnesota State Firemen's Association, the American Public Works Association, the League of American Municipalities, the American Society of Municipal Improvements, and the National Fire Protection Association. The pamphlet gives full drawings of these couplings. It is prepared for free distribution, and it is hoped that it will have considerable influence in bringing about uniformity in these important details of water works specials.

A book which will be of value to many readers of The Engineering Record among municipal and water works officials who have to be acquainted with plumbing work is Mr. R. M. Starbuck's "Modern Plumbing Illustrated." It is an octavo volume of 392 pages containing many well-drawn illustrations of plumbing of all sorts. The book explains in detail the apparatus and its installation in kitchens, laboratories, pantries, laundries, stables, barrooms and other special locations, but is mainly useful for the descriptions of the general plumbing arrangements in all kinds of buildings, ranging from cottages to large apartment houses and office structures. There is a rather full index by which the information on any subject can be readily found and there is hardly any feature of plumbing work which is not discussed at greater or less length in the book. The volume is probably the most complete general statement of American plumbing methods as executed by the best workmen at the present time. (New York, Norman W. Henley Publishing Co., $4.00.)

The little manual of the "Slide Rule," written by Mr. C. N. Pickworth, has now reached a tenth edition. It was noticed a good many years ago and the present edition does not differ materially from those which went before, the leading changes being descriptions of recently designed slide rules and special instruments of a similar nature and a general discussion of the theory of the instrument. The directions for the use of the instrument are very complete; in fact, some of the rules are rather more involved than most engineers will probably find desirable. This is particularly the case with respect to rules for finding the position of the decimal point where a decimal fraction is involved in the answer. A feature of the book which will probably be of use to beginners is the large number of examples indicating how a slide rule may be employed in various engineering calculations. The book is a good one for people who intend to take up the use of this important instrument, which should be understood by all who have to make many computations involving multiplication and division. (New York, D. Van Nostrand Co., $1.)

A part of the famous engineering hand-book written by Dr. Julius Weisbach, and revised by Prof. Gustav Herrmann, has recently been translated by Mr. K. P. Dahlstrom, under the title of "The Mechanics of Hoisting Machinery." Other portions of the hand-book have been translated into English, but this is the first appearance in English of this part. It contains a discussion of levers and jacks, tackle and differential blocks, windlasses and winches, hydraulic hoists and accumulators, pneumatic hoists, hoisting machinery from mines, cranes and shears, excavators and dredgers, and pile drivers. The book is a comprehensive, although elementary, discussion of the various classes of machinery mentioned. So far as the apparatus itself is concerned, there is little information concerning the latest types. For instance, in the first chapter, on levers and jacks, the appliances illustrated are none of them of a character which would be accepted for a minute on an important contract in this country. No mention whatever is made of modern hydraulic jacks, and the excellent types of lifting apparatus made for railway service in this country are entirely omitted. The information on excavators and dredgers is credited in various foot-notes to publications of 1865 to 1872; the type of dredge selected as typical of American practice is the old Otis machines which have not been used for 15 years at least. The information concerning pile drivers is similarly antiquated. Consequently the reader who is looking for information concerning the latest types of machinery will be completely disappointed in the contents of this book, although if a general discussion of the basic principles of such machinery is desired, the volume will probably prove very useful, as it contains the elaborate detailed analysis which characterize the whole of the Weisbach-Herrmann treatise. (New York, The MacMillan Co., $3.)

Letters to the Editor.

The Traveled Width of Country Roads.

Sir:—Engineers who have been connected with highway improvement work know what a wide diversity of opinion exists regarding the proper width for the improved part of graveled or macadamized roads. While in charge of the construction of a 12-ft. macadam road in central Illinois last summer the writer had an opportunity to observe the width actually used by country traffic when it was not influenced by fences or a prepared roadway. During the progress of the work traffic was diverted from about ¼ mile of the road by turning it through a level clover field which was crossed diagonally. The traffic was unusually heavy, since to the ordinary traffic, composed largely of teams hauling milk to the railroad, was added the teams hauling crushed stone to the road. Frequently as many as seventy-five loads of stone crossed the field in a day. The traffic through the field continued for perhaps five weeks, and at the end of that time the clover had been thoroughly killed on a 10-ft. strip where the teams had traveled. Outside of this 10-ft. strip, however, the clover was not appreciably damaged. There had been some travel outside the 10-ft. lines, but apparently it was so slight that its effect was practically negligible. This seems to indicate that a width of 12 ft. is ample for ordinary conditions.

Yours truly,

Peoria, May 10. ILLINOIS ENGINEER.

THE PREVENTION OF MINE DISASTERS.

SIR: Perhaps you have noticed in the newspapers an account of investigations to be conducted by the Technologic Branch of the Geological Survey looking to the prevention of mine disasters and loss of life and property in mining operations. Thinking that possibly the same would be of interest to you, I take pleasure in inclosing a more detailed account of the proposed operations in this regard.

The United States Geological Survey, within a few weeks, will establish probably in the Pittsburg district, an experiment station for the purpose of testing explosives used in coal mining, the ultimate object being, if possible, a reduction in the number of mine disasters resulting from gas and coal dust explosions. Miners' safety lamps will also be tested at this station, and explosives investigations conducted both in the laboratory and in the mines.

The station will consist of an explosive gallery, rescue room, observation house, lamp testing rooms and explosives laboratory. This gallery is to be made of boiler plate and will be in the form of a cylinder 100 ft. long and 6 ft. in diameter. A series of safety valves on hinges will be arranged along the top to allow the escape of gas following an explosion. Port holes along the sides, covered with half-inch plate glass, will allow those in the observation house to see whether an explosion has taken place in the gallery during the tests. The cylinder will be filled with fire-damp and air, or coal dust and air, and the explosives will be hurled into the gallery by means of a steel mortar fired by electricity from an observation house 60 ft. away. The fire-damp and air will be thoroughly mixed by an electrical fan.

All explosives, if used in large quantities, will ignite fire-damp or coal dust. Tests will be made with various explosives and the maximum quantity of each explosive that can safely be used in mines will be published under the head of "permissible explosives." Explosives known as "safety explosives," in which the temperature at the point of detonation is low and the flame of short duration, will have a higher "limit charge" than the less safe explosives.

The rescue room will resemble the interior of a mine and during tests will be filled with smoke. The efficiency of all apparatus for sustaining life will be determined by a series of tests. Miners will be shown how to rescue their fellow miners.

The observation house will run parallel with the explosive gallery 60 ft. away and will give opportunity for a number of persons to witness the tests in safety.

All safety lamps that are now used in this country will be tested, not only for their candle-power, but also for their relative safety in the presence of fire-damp. The lamps, which will be tested in a separate room, will be subject to different velocities of explosive mixtures of gas and at various angles.

All explosives will be first tested by the pendulum test and the Trauzl test, to arrive at the quantity to be used in making experiments in order to get the same disruptive force. The pendulum or English test consists of a large pendulum weighing several tons which swings backward when the force of an explosive is exerted upon its face and the distance of the swing is indicated by a delicate sliding rule. The explosive is fired from a mortar and the force of the explosion is played against the face of the pendulum. The Trauzl test consists of a cylindrical lead-block 20 cm. high and 20 cm. in diameter. The weighed explosive with the electrical detonator is placed in this central cavity and tamped with a known quantity of sand and moist clay. After the charge has been exploded the pear-shaped expansion of the bore is measured by filling it with distilled water at 16° Cent. A pressure gauge will be used for measuring the actual pressure in pounds per square inch developed by the detonation of various explosives. The analysis of the products of combustion will also be made. The heat of decomposition of all explosives in terms of calories will be ascertained by detonating large quantities in a bomb. The explosives will be fired from the mortar at night and the length of the flame will be determined by photography. The time of the flame will also be determined by an electrical apparatus. The rate of detonation will be determined by an electrical rotary recording drum.

Actual experiments will be made in mines to lessen the waste of fuel in mining operations. Several of the best explosives which have been determined by the results at the testing station will be purchased in the open market. They will be used in different mines and the amounts of lump and slack coal produced will be carefully screened and weighed. A classification of these explosives will be made in reference to the cost of explosive per ton of coal produced. Different methods of using explosives in mines will be investigated with special reference to increasing safety and efficiency.

The experiments will be under the direction of the writer as chief of the technologic branch of the Geological Survey. Dr. Charles E. Munroe has technical supervision of the tests which will be conducted at the station. Mr. Clarence Hall, explosives expert for the Geological Survey, assisted by Mr. W. O. Snelling, will have immediate charge of the experiments. Mr. Hall has recently returned from Europe where he made a study of the foreign government testing stations.

Yours truly,

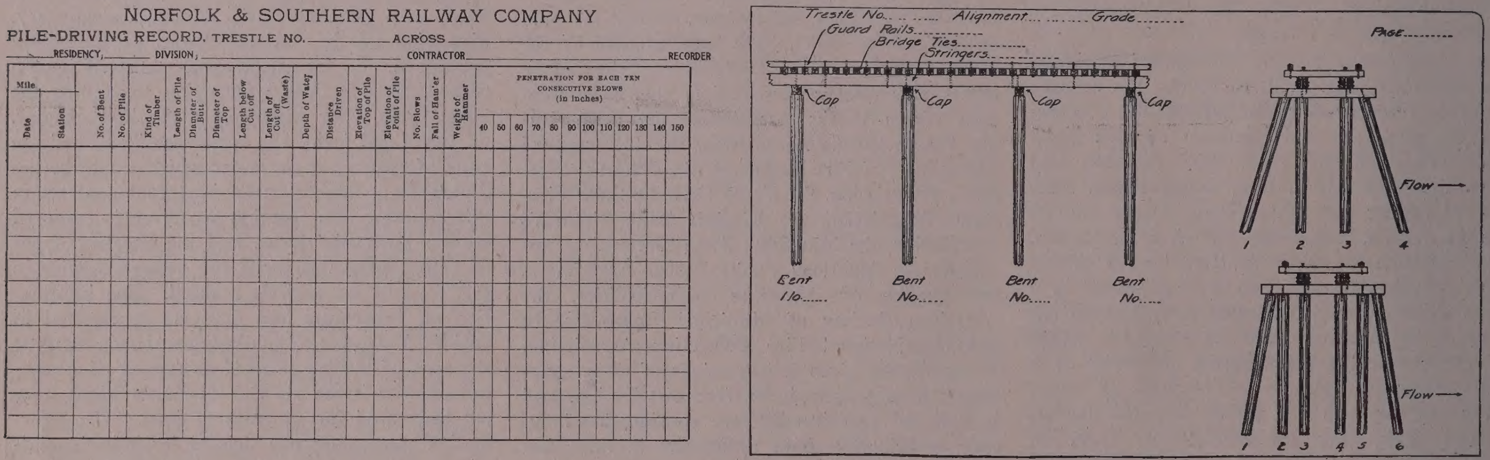
Washington, May 15. J. A. HOLMES.

PILE DRIVING RECORDS.

SIR: Enclosed herewith I beg to hand you a copy of a pile driving record that we are using on the Norfolk & Southern Ry., thinking doubtless it will be of interest to your readers. These are put up in book form, being about the size of a transit book. We also have the same kind of sheet as a record, printed on paper 8x11 in. The recorder copies his notes every night on sheets which are sent in every month with estimates.

Yours very truly,

Raleigh, N. C. THOS. W. COTHRAN.



NORFOLK & SOUTHERN RAILWAY COMPANY

PILE-DRIVING RECORD. TRESTLE NO. ________ ACROSS ________

________ RESIDENCY, ________ DIVISION, ________ CONTRACTOR ________ RECORDER

Mile		No. of Bent	No. of Pile	Kind of Timber	Length of Pile	Diameter of Butt	Diameter of Top	Length below Cut off	Length of Cut off (Waste)	Depth of Water	Distance Driven	Elevation of Top of Pile	Elevation of Point of Pile	No. Blows	Fall of Ham'er	Weight of Hammer	PENETRATION FOR EACH TEN CONSECUTIVE BLOWS (in inches)											
Date	Station																40	50	60	70	80	90	100	110	120	130	140	150

Trestle No. .... Alignment .... Grade ....

PAGE ....

Facing Pages of the Form for Pile-Driving Records Used on the Norfolk & Southern Ry.

METHOD FOR THE SOLUTION OF TRIANGLES.

SIR: When the three sides of a triangle are given and the three angles are required, a modification of the tangent formula is given in some of the books as follows: a, b, c being the sides, A, B, C the angles, $a + b + c = 2s$; r, the radius of the inscribed circle, we have $\tan \frac{1}{2} A = r \div (s - a)$, $\tan \frac{1}{2} B = r \div (s - b)$ and $\tan \frac{1}{2} C = r \div (s - c)$ as an immediate consequence of the known equation, $r = \sqrt{[(s - a)(s - b)(s - c) \div s]}$. The object of this note is a mode of proving the work based upon the equation $r = s \tan \frac{1}{2} A \times \tan \frac{1}{2} B \times \tan \frac{1}{2} C$. The following example will illustrate the mode of operation:

$$a = 42,\ b = 55,\ c = 69,\ s = 83,\ s - a = 41.$$

$$\begin{array}{rr}
co\ log\ s = 8.080.922 & log\ s = 1.919078 \\
log\ (s - a) = 1.612784 & log\ [r \div (s - a)] = 9.530712 \\
log\ (s - b) = 1.447158 & log\ [r \div (s - b)] = 9.696338 \\
log\ (s - c) = 1.146128 & log\ [r \div (s - c)] = 9.997368 \\
\hline
2)\ \underline{2.286992} & 1.143496 \\
log\ r = 1.143496 &
\end{array}$$

$$\begin{aligned}
\tfrac{1}{2} A &= 18^\circ\ 44'\ 50'' \\
\tfrac{1}{2} B &= 26^\circ\ 25'\ 35'' \\
\tfrac{1}{2} C &= 44^\circ\ 49'\ 35'' \\
\hline
&\ \ 90^\circ\ 00'\ 00''
\end{aligned}$$

The total of the second column of logarithms must be equal to the logarithm of r shown at the foot of the first column.

If this check is satisfied and the total of the three angles does not check, the error must be in the tabular work only and can promptly be located and corrected.

Los Angeles, Cal. G. A. L'HOMMEDÉ.